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Notes on Yachts

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NOTES ON YACHTS.

NOTES ON YACHTS.

(FIRST SERIES).

BY

EDWIN BRETT.

WITH AN ILLUSTRATION DRAWN BY JOHN BRETT,

AND ENGRAVED BY J. D. COOPER.

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CHAPTER I.

ON YACHT SAILING:

THE DESIRABLE KIND OF VESSEL TO BUILD, AND THE SORT OF SPORT TO BE EXPECTED.

THE word yacht is applied to a class of vessels used for seafaring as a sport, comprising a great variety of craft of all sizes, from the decked or half-decked boat that can be navigated by one man, to the floating home that can circumnavigate the globe.

Yachting is probably the most difficult, complicated, and comprehensive of all those pursuits which are denominated sport; pursuits which are at once laborious and æsthetic; recreative yet exciting; pursuits requiring an energy which is its own end and reward. It is chiefly followed by men of adventurous temperament;

by men who like life in the open air, particularly in wild weather; by vigorous men, who love to feel their own strength in grappling with, and controlling the great forces of nature; by men who delight in testing their skill, daring, and perseverance against those of their brother sportsmen in the most refined and scientific of all forms of racing; and often by men who are merely rovers, and wish to travel in the best and most delightful of all possible ways. But yachting is also followed by many thoughtful and studious men, who take a keen interest in physical science; men who have stepped within the charmed circle of Naval Architecture; a science so subtle and fascinating that it should rather be described as a fine art, and the aim and purpose of which is the production of a machine more nearly allied than any other to a living creature. The number of born yachtsmen is therefore very considerable. Many of them doubtless there are who never arrive at that happy stage of development where the possession of a yacht enables them fully to appreciate the scope of their art, and the excellent possibilities of its exercise. The number of those, however, whom fortune more generously favours, and who yet never pass from the condition of passengers or "lubbers" to that of skilful seamen, is discouragingly large; and I am inclined to believe that the extreme scarcity, vagueness, and contradictoriness of the information to be had upon the subject, is, to a great extent, the reason why it is less wisely cultivated than several other sports which are clearly inferior to it in importance and delightfulness.

The subject is a large, and in some respects an abstruse one; and probably a majority of the men who are fitted by nature and circumstances to become yachtsmen, are deterred at the outset by the obscurity in which it is enveloped; and the object of this book is to set forth in a simple way the principles upon which small vessels are constructed, and to point out the chief desiderata respecting them: to sweep away the imaginary obstacles that deter men from sailing or building yachts; and to overhaul the prejudices common to landsmen in general.

The subject of sailing, in as far as any written instructions can be of use, is indeed very satisfactorily and attractively handled by Vanderdecken in his "Yacht Sailor:" nothing better could be wished; but a rudimentary knowledge of the nature or physiology of ships is strangely rare even among the most practised amateurs, and I do not know of any book adapted to meet this want.

Perhaps the most widely prevalent of those prejudices which shut people out from the pleasures of seafaring, are the exaggerated notions they entertain of its expensiveness or danger; the only alternative to a large, well manned, and obviously safe vessel, being assumed to be a small and highly dangerous one. As this is a very natural inference, I will first point out the favourable comparison which yachting bears in this respect to other sports. Of all those which call for the exercise of skill and nerve, riding is perhaps the only one equally capable of affording adventure and excitement, and is therefore the only one which can be compared on nearly equal terms with it. The accidents incident to horsemanship are of all degrees of severity, and in the hunting-field they are as frequent as the days of a season. They may, however, be divided into two classes, from one of which the yachtsman is entirely free; for so seldom do trivial accidents occur afloat, that all of this class may be fairly excluded from the proper risks of yachting. The accidents to the horseman are, however, often fatal; and although the sailor, too, is liable to these, yet they do not attend him with that appearance of certainty which characterises their recurrence to the other. The steeplechase rider, mounted on his favourite hunter, is a man to be shaken hands with before he goes to the starting post; and remarkably good fortune only can enable him to escape unhurt. It is not so in the sailing match. No one thinks of making his will when he is going to compete at Cowes: and yet who is there that has ever sailed a nearly contested match; who does not know that the excitement is intense? and who is there that has both ridden a race and sailed a match, who can deny that the excitement of the one is equal to that of the other? The reasons why, in this comparison, the danger of yachting shows so favourably are very simple. The horseman and the yachtsman both incur the possibility of their skill failing them at a critical moment, and entailing an accident; but in addition to this chance, the horseman also incurs the possibility of his horse's skill or ability failing under emergencies; and so, supposing the horse to be as good as his rider, from this cause only the chances of accident are doubled. The horse, too, has a will of its own, and when that happens to be contrary to that of the rider, the latter is very liable to get the worst of it.

The temper of the yacht is always that of her commander, and therefore there is never a tussle in which she gets the best of it, and lies down and rolls on one, or grinds one's leg against a wall; neither can the skill, forethought, and self-possession of her commander ever be thwarted, for a mistake on her part is impossible. To follow out the comparison with all the other out-of-door sports would not lead to any useful results, for, as I said before, it would not be a fair comparison between a highly adventurous and exciting sport, and others which did not embrace these characteristics. Only by way of illustrating the actual amount of danger which attaches to yachting, I would call attention to shooting, which exactly equals it in the particular respect under consideration. For when a gun or yacht is well handled, the probabilities of danger in either case are reduced to a minimum; and it is only, in the one case, when shooting in company with inexperienced or foolish men, or in the other, sailing under the command of an incompetent captain, that danger shows itself in any appreciable degree. The cases in which a bad gun or yacht are used need not be considered, as no sensible man ever meddles with either.

The cost of buying and maintaining a large yacht is well known to be very great; but this expense varies with the size, and not necessarily with the quality of the craft. This is a most important point, and one which I imagine has been somewhat overlooked by yachtsmen; and one of my chief objects in writing this book is to point out the peculiar excellencies of small vessels, and to show in what particular respects the little yacht which costs no more than a hundred pounds, is superior even to the two hundred-tonner that costs five thousand.

The uses of large yachts are very serious and important: perhaps the most conspicuous of them is one that all Englishmen appreciate. In no other way can long distances be travelled with comfort. Very young rovers indeed measure the importance and success of their journeyings by the number of petty hardships they have encountered and surmounted; but to a man who has travelled through his minority, and has begun to travel for a purpose, there is no satisfactory conveyance but a yacht of a hundred tons and upwards. And a man who has once thus wandered with his home at his back, has tasted one of the extreme enjoyments that this life is capable of yielding. To be able to entertain one's friends, too, is so obvious an advantage as hardly to need mention. There are other collateral advantages of large yachts; the chief of which perhaps is the renown that is to be attained in the winning of the great sailing-matches.

In no one respect is the mere pleasure of sailing increased by the size of the yacht; on the contrary it is diminished; for the smaller the ship, the more immediately she is under one's own control; and if she is so small that a man may manage her alone and unaided, then he gets the utmost amount of pleasure that the art of sailing is capable of yielding: all she does is his doing, and his boat becomes a part of himself, completely obedient to his will. Directly any one helps him to work her, then the glory of her performance is shared with that other, and so reduced; and if the vessel is large this feeling may be lost altogether, for the command of a crew is a troublesome and arduous undertaking, for which the services of a professional sailor are indispensable, and the pleasure of sailing has to be transferred from the owner to the sailing-master. The skill, too, that is requisite to handle with grace and safety a small yacht is incomparably greater than is necessary to control the movements of a large one. In the small yacht there is a delicacy required in every touch of the tiller and gear; and besides this, there must be a forethought to avoid, and a presence of mind to meet emergencies which in a large craft would never occur. A large ship will take care of herself through a hundred little trials that would prove serious to the small one; and yachtsmen are well aware that from this cause a man-of-war's man or sailor out of a big ship is nearly as useless on board a yacht as a landsman; he follows a certain routine and lets her take care of herself; while the man who sails his own boat alone, forestalls her slightest wish, and humours her out of her childish pranks till she looks to him for his consent to every step she takes; and it is the man who is accustomed to these intimacies and delicate reciprocities who knows the real pleasures of yachting, and not the man who has never sailed in anything less than a fifty-tonner.

A taste for yachting is an acquired one, and capable of very extended culture. The yachtsman may be said to belong to a race of superior beings, whose faculties have an unbounded range. Instead of a certain limited patch of earth, the entire globe is his domain. His freedom is not the freedom of a city, but of a planet; and the most refined and educated of men can only be ennobled by its attainment.

This exalted pleasure can be experienced in different degrees, according as it is pursued in different methods, of which there are four principal ones. A man may sail as a passenger on board a friend's yacht, or as a passenger on board his own yacht; he may sail the yacht he has bought, or sail the yacht he has designed. Each of these methods yields a distinctly different intensity of pleasure; the first certainly the least; nor is it greatly enhanced in the second, for there is a helplessness in both that greatly detracts from the otherwise wholly pleasurable effect. Very subtle causes are involved. First, there is the strangeness of the situation—floating upon a foreign element, and completely isolated from one's fellow-creatures. Then the attractiveness of the science that enables one to achieve such a complete victory over nature. And lastly the pleasing sense of onward movement in whatever direction we choose. This latter is irresistibly fascinating to everybody. Movement by the direct exertion of one's own powers is most undoubtedly the drudgery of one's existence, and to get it done by some other force or contrivance is always considered a luxury, although it is mostly obtained at the expense of some less fortunate creature, and always at the expense of much coin. To avail oneself of the four winds of heaven, is to utilize a force as powerful as it is universal, and the cheapest in all nature; while the adaptation of its ever-varying resources to the several purposes and ends of the sailor, and the capabilities of his craft, forms a constantly interesting scientific problem.

The exercise of the skill which compels the obedience of the boat, is however an additional source of pleasure known only to the man who sails her himself; and here the difference between being sailed as a passenger, and sailing the yacht oneself becomes apparent. It is equal to the difference between driving a four-in-hand oneself, and sitting on the top of a drag that is driven by another. Both may experience the same pleasure from the excitement of the situation, the changing scene, and the fascinating movement; but the passenger is a stranger to the pleasure of being the cause and controller of it all, and the master of a graceful and difficult art. With the experienced yachtsman, obedience will follow every action of his hand; and the movements of his boat will be the result of little more than the exercise of his will.

There is only one higher object for him to aspire to; one which developes and demonstrates his knowledge of the subject, and yields a gratification beyond all comparison greater than either of the former, and that is to build one's own vessel: to design her, and overlook her construction oneself. Her owner may then take a just pride in all her creditable performances; and in her triumphs he will experience something akin to the feelings of the father of a famous son; while even her little waywardnesses and failings cause very different feelings from similar misconduct in the child of a stranger.

There are several obvious reasons why this highest development is not often realised. Amongst men who are fond of sailing, those who go as passengers on board their friends' vessels, are with few exceptions such as cannot afford to keep yachts themselves, or have no opportunity of doing so; whilst those who always remain passengers on board their own craft, are merely idle, uninteresting persons. But the knowledge and skill required for the production of a design of average excellence, is by no means inconsiderable, and if such a vessel is the utmost object aspired to, there are doubtless plenty of them in existence already, and to be had at prices considerably below the cost of new ones. This difference in cost, however, is seldom the principal obstacle to the amateur who is deeply interested in the subject, and competent to carry out his own particular views. He is discouraged by the blundering and empiricism of the practical builders; and argues that if with all the accumulated experience of years, and all the pains that have been taken to correct ascertained errors, and compensate for known defects, such a vast number of bad ships are turned out from the yachting ports, his own theoretical knowledge and moderate experience are hardly likely to carry him through the practical test of the building-yard triumphantly. He takes note that sound principles of design are nearly always ignored, or but vaguely perceived by the builders, and that their vaunted improvements on earlier models, too often turn out to be something quite the reverse, or merely the substitution of new faults for old ones; but the voices of all his friends chime in with one accord to the old chorus, "Fools build houses for wise men to live in:" no word of encouragement is uttered; he is not a man of great self-conceit; everything is against him, and so he reluctantly contents himself with building imaginary yachts in the air, and buys the best real one he can find in the market, for present use.

Yachts are designed with a variety of different objects in view, and the purchaser of a second-hand one is often disappointed, because he harbours preconceived notions which she was never intended to meet; and if his notions are those of an intelligent and cultivated sailor, it is unlikely that he will ever find them completely realized, even amongst the multitude of vessels always offering for sale. That yacht building has made progress, is, if we include a long period of history in our review, an indisputable conclusion; but the reason why new yachts are ordered is unfortunately oftener to obtain trivial peculiarities of accommodation, than with the view of developing the art by the production of a ship essentially superior to those hitherto constructed. There are happily certain exceptions, and we owe some of the most conspicuously successful of existing vessels to the genius of amateurs; amongst them the names of the late Mr. Weld of the "Alarm," and the present Mr. Frank Powell of the "Aglaia," will occur to those conversant with the subject. That there is a magnificent field open before the nautical amateur who has time on his hands and any enthusiasm for the subject, is very evident.

Professional yacht-builders generally lack two, if not more, of the principal requisites for advancing it. They lack time and education; and in the latter particular there is no prospect of improvement until it becomes manifest that the amateurs know wheat from chaff. So long as handsome orders are the reward of stylish appearance and convenient fittings, rather than of scientific design and perfect drawing, things will certainly remain as they are, and the intelligent yachtsman must design for himself; and not only design, but watch the whole performance of the contract from beginning to end; and a more delightful, improving, and rewarding expenditure of energy it would be difficult to point out. To mince the matter is of little use. To *meddle* in the building of a vessel is even worse than useless, for it only takes the sense of responsibility off the shoulders of the builder, while the ends of the meddler are sure to be defeated.

As long as the amateur is as ignorant as the builder, he is right enough to let him have his own way; but then he need not build at all; it would, however, be greatly to his advantage to go to the root of the whole matter, and build a craft that should reflect his own individual genius and respond exactly to his requirements, or, if that be not at once attainable, at all events to improve himself as a yachtsman whilst endeavouring to explore, or haply to advance, the science of Naval Architecture.

CHAPTER II.

EXISTING YACHTS.

NOTWITHSTANDING the remarkable fact that no two individual yachts are alike, the fundamental laws of Naval Architecture are so few and so absolute that all the practicable varieties of form may be comprehended under two broad distinctions. They are all either deep or shallow vessels, and may be described with equal exactness by the terms narrow, and broad. They are never both deep *and* broad, or shallow *and* narrow; for such proportions would not embrace the qualities necessary to yachts; though there certainly are vessels built after these descriptions;—the ordinary coasting trader being an example of the one, and an outrigged sculling boat an instance of the other.

Deep yachts are those of which any longitudinal vertical section is of greater area than any horizontal one; and in shallow yachts the reverse is the case. A model of a yacht of the former class, if cut in solid wood, will not float with its deck upwards, but the plane of its greatest section will tend to assume a position parallel to the surface of the water. This model will continue to belong to the deep class until, by reducing the draught, she will float with her deck horizontal, and then she will be an example of the broad or shallow vessel.

These classes are therefore distinctly separated, and comprehend all yachts. Each class has peculiar qualities, more or less pronounced according to the degree of prominence to which its leading feature is developed, the most important of them being speed, and sea-worthiness (or the ability to go to sea in all weathers), one of which is generally obtained at the expense of the other.

Narrow yachts are possessed of abstract speed, which is the result of one simple cause, namely, the fineness of all their horizontal lines. The two sides of a narrow vessel lie at a small angle to one another, and the horizontal sections are necessarily sharp. All narrow sailing-vessels must be made deep (in order to carry their ballast low down, and obtain in that way the stability they lack by reason of their want of width); and the result of this depth is, that they offer great resistance to lateral movement, which prevents their driving to leeward when sailing on a wind. Besides these valuable qualities, two others may be mentioned as collateral advantages belonging to deep yachts,—the greater height in the cabins; and the favourable conditions they offer for measurement; this latter however, is merely contingent on the present arbitrary rules which guide yacht clubs in their estimation of size for classification in sailing matches. Yachts of this sort, on the other hand, are bad sea-boats. Their natural tendency is to lie on one of their sides; and to counteract this, more ballast has to be carried than would be necessary merely to resist the pressure of the wind on their sails, and their buoyancy is thus seriously diminished. A yacht of this description, instead of being like a cork on the surface of the water, is more like a thin piece of soap, which will just give a casting vote in favour of sinking; once bury her under a breaking wave, and there she will remain, not having sufficient buoyancy to come up quickly. All her vertical sections (buttock lines) are bluff at the bows, the result of which form is, that as the vessel moves onward, the impact of the bows with the advancing wave is too sudden to allow of any upward pressure being developed: the lifting curves are too obtuse to be effective, and so she is driven through, instead of over obstructions; and as each wave approaches, it merely becomes a question of how high it is as to how much of it will break over her; if it is big enough it will swamp her, but if it is not quite big enough for that, she gets through it with only a thorough wetting, and the next moment encounters another to go through the same process. These peculiarities—the want of buoyancy, and the inadaptability of the form of the bows for lifting the vessel over waves, render these yachts bad sea-boats, or fit only for fair weather; besides which, there is the serious disadvantage, that great draught of water is often an insuperable obstacle to going where one wishes. It appears, then, that the merits of deep yachts are,—speed, weatherliness (the power of sailing well to windward), good head-room in the cabins, and the advantage of measuring small: while their defects are,—bad sea-going qualities, and the limitation of one's cruising to the deep sea.

The prominent excellence of the broad and shallow class is their greater safety in rough weather. Their normal tendency is to keep right side up (which may be looked upon as a desideratum in a yacht), and in consequence, comparatively little ballast is necessary, so that they are buoyant and lively. And in addition to this, their buttock-lines present such a small vertical angle to the waves, that they are lifted over, instead of being obliged to plunge through them. Light draught of water is, in itself, an immense advantage, though it is one that can be thoroughly appreciated only by the man who has spent a night on a mud-bank. The pleasure of being able to cheat tides which a vessel of deep draught must stem; or make short cuts over sand-banks which the other must go round, are not insignificant considerations; and it will be obvious to every one how greatly this quality extends one's cruising-ground.

On the other hand, three distinct causes tend to make broad yachts slow sailers. Their horizontal lines are bluff, and the consequent resistance to onward movement is great; while the propelling force is diminished by so much as is devoted to lifting the bows. They are deficient in lateral resistance, and consequently make much leeway on a wind. And when they are careened by a breeze there is a strong tendency to gripe, caused by the greatly increased area of the water-line to leeward, in counteracting which the action of the rudder hinders the progress considerably. The rudder of a shallow vessel is, in short rough seas, liable to be lifted out of water and rendered useless for the time; and although the probability of such an occurrence is somewhat remote, yet the tendency to it is sufficient to render the effect of the rudder variable. And in yachts of this class, the cabins are necessarily low pitched.

The chief merits of the shallow class are, that they are good sea-boats, and can sail in shallow water. And against them can be urged as defects,—that they are slow, and make much leeway on a wind; are difficult to steer, and have bad accommodation.

It is desirable, while speaking of deep and shallow yachts, to allude to the very general supposition that the deep ones are slow before the wind. This has arisen from comparing a deep and a shallow vessel when sailing close-hauled, and then again comparing their speed when they are sailing free; in which latter case it is seen that there is not nearly so much difference between their progress as before, and the conclusion is drawn that the deep ship's great draught, no longer giving her the advantage of lateral resistance, causes her to sail slow. This is a mistake, for the deep vessel is, on account of her shape, faster at all points of sailing than the shallow one; and if the shallow vessel more nearly attains the same speed when they are before the wind, it is because she no longer suffers under the disadvantage of drifting to leeward.

The same two broad distinctions exist between all sailing boats, as between all yachts, and the same qualities are developed; but there are requirements in boats, which considerably alter the value to be placed upon them. These little craft are so much more at the mercy of the wind and waves than large vessels, that sea-going capabilities become in them of paramount importance. Buoyancy must be preserved at all cost, and in doing this, the rejection of heavy ballast sweeps away with it nearly all the good qualities of the deep and narrow class; whilst those of the broad and shallow sort assume the position of necessities.

Most yachts are rigged either as schooners, yawls, or cutters; and although there are other modes adopted occasionally, they are nearly all fore-and-aft rigged vessels; the only reasonable exceptions being in cases where the yacht is very large, when fore-and-aft sails would be unmanageable from their great size.

It is not my purpose here to discuss any of the unusual fashions of rigging, but only to consider the three ordinary ones which I have alluded to, in order to point out their peculiarities, and estimate their relative values.

The cutter is distinguished for speed, and when turning to windward, she shews a pre-eminence in this respect over every other craft.

This excellence is obviously caused by the concentration of the greater part of her canvas in *one* sail, by which means all the wind it is capable of holding is economized. As the wind traverses the surface of the sail it becomes condensed, so that the after part sustains a much stronger pressure than the fore part of it; but if the sail were divided perpendicularly down the middle, and the two halves were set with a gap between them, the after-half would have to collect the wind for itself, instead of receiving the condensed draught from the forward half, and so each portion would sustain an equal pressure. This is the reason why a large sail is generally more effective than two or more small ones which together contain the same area of canvas; but when sailing dead before the wind, or when the sail can be set at right angles to it, any number of little ones are just as good as if all were concentrated in one. A large sail involves a heavy mast and boom, and the evils they entail in rough weather are sufficiently obvious; but the fact is indisputable that, in tolerably fair weather, and with the wind before the beam, the cutter can shew her stern to any other craft afloat. This desirable result must not, however, be attributed to the scientific disposition of the sails, for that is manifestly defective. Although the centre of effort of all of them may be brought into the correct position in relation to the lateral resistance, the method by which this is done involves a fault. There is a large sail nearly all abaft the centre of lateral resistance, and two small ones before it. The lateral pressure of the former predominates to such an extent that it would immediately turn the vessel round and leave her head to wind, were it not counteracted by the location of the head sails at a position further from the fulcrum (that is to say over the bowsprit instead of over the hull), so that by their greater leverage a balance is established. If the centre of lateral resistance (the fulcrum) were a fixed support which was never shifted by the vessel's pitching, then this disposition of the sails would be as perfect in its working as if their whole pressure were really applied at one point; but every passing wave increases the lateral resistance towards one end, while reducing it at the other; and whenever the less supported end happens to be the bow, the head-sails take an uncompensated advantage of it by reason of their greater leverage, and cause her to fall off to leeward; and unless this is counteracted by the control of the rudder, the vessel deviates from her course. I will not here go into the detail of how such an evil tendency may be avoided, as it will come under consideration in another place, but only point out the simple fact, that if all the pressure of the canvas were situated over a common centre of lateral support and oscillation, no amount of pitching and scending would result in the vessel's yawing about, or going off her helm.

Yachts rigged as schooners, although they suffer in a modified degree from the same cause as cutters, have not the great redeeming quality of speed. Their two principal sails are comparatively inefficient on a wind, and are indeed only set to the best advantage when the wind is quarterly; but they are very handy, and can be managed by a smaller crew; while the lightness of the spars is a conspicuous advantage in bad weather.

The yawl rig, as it is at present adopted in many of our yachts, is not distinguished by any remarkably good or bad properties; it is a compromise between a cutter and a schooner, in which neither the glaring defects nor the eminent good qualities of either are retained. The chief respect in which a yawl may be looked upon as an improvement upon either of them, is in the position of the sails. The large sail is placed nearly over the centre of the lateral resistance, and in doing this a great step is made in a direction which, if faithfully pursued, would lead to invaluable results. The mainsail, although of very considerable size, is still handy, for it is all inboard, and reefing it is a comparatively easy operation to what it would be if it projected a long way over the taffrail; and the facility afforded by the mizen for correcting the balance of sail, or in tacking, is most valuable. With its aid, to miss stays even with the lightest or most baffling breeze, is impossible.

All the defects of the yawl rig as now exhibited, may be traced to the design of the hulls to which it is applied, rather than to the inefficiency of the rig. They are slow when compared to cutters; but this is not from the incompetency of the rig for speed, but because the mast is not carried sufficiently far forward to set the requisite quantity of canvas; and if it were, they would pitch dangerously; but that both these objections can be removed, and that a proper adaptation of this rig is, on the whole, the most perfect one for yachts, I hope to be able to prove in the course of these pages, even to the satisfaction of the most prejudiced of cutter sailors.

The foregoing characteristics of yachts are seldom, if ever, exhibited in glaring simplicity. Practical builders are aware of the evils involved in so doing, and without logically following out the operation of cause and effect, they generally manage, by an instinctive application of the adze, to produce a compromise or botched result which shall compare tolerably with all that has gone before.

The most common yacht has a deep hull, and a monstrous spread of canvas: is fast, unmanageable, and dangerous. Next, there are the old-fashioned little cutters, with good beam carried considerably below the water-line, and of medium depth: they are quick in stays, tolerably safe, troublesome to steer straight, and are but dull sailers.

Then there are the several sorts of schooners, which vary chiefly in their degrees of slowness. They are too often long, low, and crank; but seldom come to grief, because they are generally owned by men who care only for very fair weather cruising. These are floating kitchens and bedrooms, and lie mostly in the Solent or some other convenient anchorage. It is true there are a few splendid exceptions among schooners—those built by Mr. Steel, for example, and probably the best achievements of modern builders may just now be found under this rig.

There are many wholesome yawls too. These are seldom ugly craft, for their rig always insures that degree of beauty which depends on symmetry.

On the whole, however, it is impossible to look over the existing yachts without coming to the painful conclusion that they do not attain that relative excellence as compared with other craft (fishing-boats for instance) which the circumstances would lead one to expect; and that instead of being proud of our "pleasure fleet," we may more reasonably entertain an opposite feeling.

CHAPTER III.

ON THE SHAPE OF THE HULL.

SHIP-BUILDING is not strictly scientific work, nor entirely an art. It is indeed, generally speaking, pursued through the length and breadth of the world as an art; that is to say, most of the ships that are to be found on the high seas are constructed by men innocent of any mathematics beyond the simplest relations of numbers. Yet there is probably no subject more adapted to tax the most cultivated intellect. There are several exact systems followed by certain enthusiastic builders, but these are exceptional; and for the most part, experiment and compromise widely prevail, not only amongst those whose object is to supply the general demand for carrying ships, and to amass profit, but also in the yards of the yacht-builders, where any degree of superiority would insure fame. There, indeed, the great rule of thumb is more than anywhere else predominant.

There are certain leading principles, however, which are followed, often instinctively rather than rationally, in the construction of all sailing vessels; and it is desirable that the yachtsman should have a clear and well-defined conception of them in order that he may know on what the performances of his vessel depend, and how far he may rely on her answering to his demands.

The subject of stability is involved in considerable obscurity; and although most men, if they wish their yacht to be stiff, attain their end, either by making her broad, or putting a quantity of ballast into her; yet the relative values of the stability obtained by these means are not estimated with the nicety they deserve, and a just discrimination in their adoption is consequently impossible.

When a ship is on dry land she weighs, say, so many tons, which weight, though unequally distributed, has one centre or point of average, called the centre of gravity. When she is floated, she displaces a mass of water which weighs exactly as much as herself. The pressure of this displaced mass against her bottom and sides is what keeps her from sinking—exactly neutralizing her weight. The centre of this support is called the centre of buoyancy, and since the pressure of the water is uniform in all directions, it is always situated exactly in the centre of figure of the immersed part of the ship—no matter what the shape of that may be.

It appears, therefore, that these two important centres are the foci of two equal but opposite forces: the downward force of gravity, and the upward force of buoyancy; and it is upon the situation of these in relation to each other, that the important quality of stability depends;—the stability of a ship being understood to mean a tendency to recover her upright position when other forces are trying to capsize her;—and the disposition of these centres so as to attain an eminent degree of stability without hindering the speed or otherwise spoiling the vessel's performance, is one of the chief problems which the naval architect has to solve.

Of the two, the centre of buoyancy is most under his control; for the great latitude of movement which is possible to it, depends entirely upon the shape he chooses to make his hull.

The only way in which he can deal very effectively with the centre of gravity, is by the disposition of the ballast. And the development of stability, as far as this centre is immediately concerned, depends on placing it at the lowest possible point; and if he can succeed in getting it below the centre of buoyancy (the weight suspended below the point of support,) he may be sure of one thing—his ship cannot be capsized; that is to say, her tendency to right herself will be perpetual, and when she is laid on her beam ends it will be even more energetic than ever. A simple instance of this stability by ballast could only be shown in a hull of cylindrical form, but as that form would not be expedient on other grounds, it may be said never to be practically exemplified except in combination with that stability which is produced by manipulating the centre of buoyancy, and which is commonly called stability by form. The centre of buoyancy, as I have pointed out, is the centre of that cavity in the water in which the ship lies, and if her hull were round, she could be canted over to any degree of inclination from the perpendicular without disturbing its position, inasmuch as any one segment of her would be of the same shape as any other. But it is evident that if her bottom were somewhat flattened and made wider than it was deep, then it would be impossible to alter her position without altering the shape of the cavity in the water, and causing its centre to be shifted to one side; for on the lee side she would be more deeply immersed, and on the weather side less so than she was when floating upright. By means of widening the ship, therefore, it becomes possible to place these centres in a very advantageous relation: the centre of support well away to leeward of the centre of gravity, so that they shall reciprocally assist each other in resisting the efforts of the wind to capsize the ship.

Most ships carry their centre of gravity above the centre of buoyancy, so that it is cast somewhat over to leeward as the pressure of the wind lists them out of the perpendicular, and although a given weight is in that position less energetic in righting them than if it were placed lower, yet the recovery is no less certain as long as the shape provides that the centre of displacement shall be carried still further to leeward. In order to appreciate how great are the resources of stability by form even under this disadvantageous condition, it is only necessary to consider how absurdly impossible it would be for a ship to capsize in a fore-and-aft direction. When she pitches, her centre of gravity is certainly thrown forwards to some little extent, but her centre of buoyancy is transferred a long way ahead by the increased immersion of her bows.

It is evident that the limits of this resource may be arrived at before a vessel is laid on her beam ends; and the critical point once reached, she will immediately proceed to lie bottom up.

On the other hand, the advantages of placing the ballast extremely low are obvious in allowing a great press of canvas to be carried; but it must not be overlooked that there will be some tendency to pitching and rolling developed from the pendulous oscillation of the centre of gravity below the buoyancy from which it is suspended.

Intimately connected with the subject of stability, is that of lateral resistance. This is chiefly dependent upon the area of the vertical longitudinal section immersed; but as the sides and bottom of the vessel are not presented at right angles to the direction of lateral movement, the efficacy of this area in preventing the ship from going to leeward, depends also upon the breadth in comparison with the depth; and it is further influenced by the infinitely-varying curves of the bottom; so that one datum only respecting it is certain, namely, that in vessels whose areas of vertical longitudinal section are equal, the narrower the hull, the more effective will be the opposition to sideway movement.

The requisite amount of this resistance is just so much as will neutralize all that part of the wind's force which is not effective for driving the vessel a-head; so that it bears a fixed proportion to the resistance to onward progress. The more difficult the ship is to move forwards, the more lateral resistance is necessary to prevent her from going to leeward. Thus the principal proportions of the vessel—her length, breadth, and depth, are governed by the considerations of stability and lateral resistance.

The speed of a yacht depends primarily upon the shape of her ends, and as there is no definite principle established for their design, very great variety is found in existing models; almost the only particular in which designers seem to have agreed being, that the two ends shall not be alike. Several reasons for this dissimilarity are constantly and confidently set forth; some of which sound plausible enough, while others are obviously fallacious. One of the most generally accepted is this: that the water does not flow into the vacuum left by the vessel's progress, in the same form or with the same velocity as it is displaced by the bows. Opinions upon this point have undergone considerable changes, and are even now in but an unsettled state. It was formerly imagined that the great obstacle to onward progress was the vacuum left a-stern; and the after-part of the ship was therefore tapered off very gradually, while the main breadth was placed well forward; a system known as the cod's head and mackerel tail principle. This opinion afterwards gave way to an opposite one, which may be called the thin end of the wedge principle. The gradual division of the water at the entrance came to be regarded as the great desideratum, and some experiments which went to shew that the vacuum behind might be left to take care of itself, or nearly so, were readily accepted as conclusive by the builders, who were only too glad to get a space somewhere in which to locate their buoyancy; and their employers were no less so to find that science prescribed a convenient cabin. A modification of this latter principle is the one now generally followed in the design of all yachts. A long, and therefore fine fore body is obtained by placing the main breadth some way abaft the middle, and a certain degree of fineness for the after body by making the vertical sections of it diminish gradually; producing in effect two wedges; one long one placed vertically for the bows, and another shorter one horizontally for the run, or immersed after body. This is slightly varied in some models which have not been altogether without fame, by commencing the run or after wedge well forward of the middle, while the greatest breadth at and above the load water line is kept considerably abaft that point, so that the two wedges are made to overlap, and produce an inclined or raking midship section.

The breadth on deck in this very generally approved form is carried back to the taffrail with but little diminution, giving great buoyancy to the quarters, great support to the weight of the boom, and plenty of room to dance quadrilles on deck. Probably the buoyant quarters are often required to support the huge boom in modern cutters, but this does not apply to any other rig; and the reason assigned for their general adoption, is the lift that they give the vessel when overtaken by a following sea, which would otherwise, it is supposed, break over or "poop" her. It does not, however, appear why this "lift" is not at least equally desirable for the bows; for their impact with an approaching wave, when beating to windward, is so much more violent by the addition of the vessel's speed to that of the wave, that if valuable anywhere, one would think this property would be doubly so in the fore part of the vessel; but so far is this from being the case, that when hard pressed by a following sea, it is the invariable practice of sailors to heave their ship to, and keep her as nearly as possible with her head to the wind and waves. Whether there is some other more sound and more subtle reason that induces its universal adoption, I am unable to say; but it is clear that those urged by its advocates are insufficient.

The rule of design which Mr. Scott Russell has based upon his wave line theory, prescribes a certain fixed degree of dissimilarity between the two ends of all vessels. In accounting for this necessity, he says that the water which is displaced by the fore part of a ship can be made to go in any direction we please, and therefore he adopts for the forward end a form which he says he knows to be that of least disturbance; but the water which flows to fill the vacuum left abaft the greatest transverse section, will take its own course, and therefore to annihilate this vacuum, the after part of the ship must be made to fit the replacing body of fluid; and as this body takes the form of wave of the second order—as he terms it,—he makes the after part of his ship of a like form, that it may match it, and so annihilate the vacuum. This form is an *S* curve, differing from his curve of least disturbance in being fuller. Premising that Mr. Scott Russell's conclusions from the experiments by which he discovered the form of this wave of the second order, were sound, this form of after body is the best possible one; and a fuller wave line being good for the after body, and a finer one good for the forward body, then of course a sound reason is assigned why they should be made dissimilar; but that either of these forms permits of high speed appears questionable on several grounds.

The fore part of a vessel constructed upon this wave line principle, presents the several parts of its surface at varying angles to the direction of the ship's movement; which disposition I conceive to be ill adapted to easy progress. If the water were a block of tough wood, and the ship were a wedge that had to split it, it would be reasonable that the wedge should be made with its sides concave, and terminating in a very fine edge. The edge fine, that its entrance might be easily effected; and the sides concave, that their angle might rapidly increase. As the split opened, unless the angle of the wedge increased, the big part of it would not be doing its share of the work, for its sides would gradually become more in the plane of the sides of the split. Therefore, for every part of the wedge to perform an equal part of the splitting, it must be made concave, and so always keep its sides at the same angle to the gradually opening chasm. But the simile of a wedge and a block of wood will not apply to the bows of a vessel and the surrounding water. Every part of a ship's bow in motion acts upon the water at the same time. Each individual portion of the surface has an amount of resistance to overcome equal to the area of its transverse section; and because a small portion has gone before, it in no way reduces the resistance to be overcome by a succeeding portion. If the water-lines are made hollow at the bows, the effect is merely to shift the pressure on them; the fine part that goes first sustains little, and just abaft that, where the concavity places the sides at a greater angle to the direction of the ship's progress, the greatest pressure is sustained. And not only is most pressure sustained there, but it is also obvious that wherever there is a concave surface in motion, the water must be compressed in front of it by the convergence of the directions given to the several particles; and so the whole amount of actual resistance is increased.

An exaggeration of the form will clearly show whether that disposition of the pressure which the hollow bow tends to produce, is bad or not. If, for instance, the bows were cut off at right angles, the transverse surface being made concave, and a long spike left sticking out in front,—this as a form calculated to facilitate a ship's progress, would be ridiculous; but it would only be an exaggeration of the form of bows constructed on wave water-lines. Concerning the wave lines of the after body, much the same may be said, with only this difference, that, where in the fore-body the concavity caused increased pressure, in the after body it would cause increased vacuum. One part of the surface of the ship's quarters being recessed, there would be a tendency to a vacuum there; the existence of this to a practically pernicious extent only depending upon the degree of concavity; and if for the sake of argument it were exaggerated, the same ridiculous result as at the bows would be produced, namely, the nearly square end to the ship with the blade sticking out astern.

Among the qualities claimed for this principle besides that of speed, there are several which are doubtless valuable for trading ships; and there are others which are merely the result of its being a complete system, and as such, perhaps, better than none. The capacity for carrying cargo is the same in a ship with a wave waterline, as in one of the same dimensions with a straight one; but in the former, that cargo is concentrated nearer the middle of the vessel, and so makes her more seaworthy in several respects than if it were extended over a greater length. This, however, cannot apply to a yacht; for no yachtsman would dream of putting ballast in the ends of his vessel; nor is there ever any occasion for doing so, there being plenty of space for the heavy materials used for that purpose in the centre; therefore to make the ends of a yacht small that they may not be capable of containing anything, is not such an advantage as would induce one to adopt a system of which that peculiarity was urged as a recommendation.

The tendency to pitch is a fault which, it is alleged, is reduced by making the bows fine; and this is true; for were the bows very bluff, square for example, they would be buoyed up to the top of every wave they encountered, and descend with great momentum as they were left unsupported by the passing seas; but this is a quality without some of which a vessel would be most unsafe, and to make a ship very fine at the bows is decidedly dangerous, for she will not possess sufficient buoyancy there to lift her over anything, but will push clean through the waves, and for the time being will experience greatly increased resistance and friction. The most advantageous amount of this buoyancy at the ends must vary with the distance it is placed from the centre. In long ships (the length of leverage being great) doubtless less buoyancy will effect the desired result, than in short ones, where the power is nearer the fulcrum. In apportioning these various degrees of fineness, the wave line principle shows to the great advantage that any complete system must do under like circumstances; but that it does not produce an injudiciously fine entrance and a wet ship, is by no means evident.

The superior stability involved in the wave form of water-line over any other is undoubted. Its displacement being concentrated nearer the centre of the ship, a portion of it is necessarily at a more effective distance from the middle line, and consequently yields more stability within the same circumscribing dimensions.

The qualities claimed for this principle may be reviewed as follows:—speed, and reduced pitching to say the least of it, are not substantiated; capacity, and that sea-worthiness which is gained by the disposition of cargo, are not considerations applicable to yachts; and in stability only it shows to advantage.

For these reasons Mr. Scott Russell has probably fewer disciples amongst yacht-builders than the attractiveness of his scheme and the elaborate character of the experiments out of which he developed it, would at first lead one to expect.

Another system for designing the ends of a ship is laid down in Lord Robert Montagu's book on Naval Architecture; but when one considers the very interesting way in which the principle is propounded, and the completeness of his argument in its support, one can hardly fail to regret, that he suppressed the information upon which its practicability entirely hinges. Whether this omission is accidental, or the consequence of insufficient practice in its application, does not appear. It would be presuming on my part to point out what I conceive to be required to fill up this blank; and I content myself with calling attention to the excellent points of the system, and to the exact position of the missing link. The basis of Lord Robert Montagu's principle is that the motion of the water along the ship's side, will be in a direction at right-angles to the timbers. Therefore to make the vessel's hull of a good shape, he proposes that her timbers should be drawn at right angles to fair lines running from end to end of the vessel. For these lines—which he calls dividing lines,—being at right angles to the timbers, are in the direction that will necessarily be taken by the water. These, therefore, are the ones he lays down first, and makes of a fair and beautiful shape, and then, at right angles to them, draws the timbers. In this method the horizontal sections, commonly termed water-lines, are entirely ignored for designing purposes, they having nothing whatever to do with the direction which the water takes along the vessel's bottom; though as guides to the builder, any number of them may afterwards be drawn. This theory is fundamentally sound, for it cannot be doubted that the direction of a displaced particle of water would be such as he describes it—the same that would be taken by a thin plank laid against the ship's side,—provided always that there were no other particles hard by, imbued with the same intentions, and liable to interfere with the purposes of the first particle as to his choice of a route; and it is evident that the whole mass of particles could only be freely indulged if the circumstances of each were the same, that is to say, if the sides of the vessel were so moulded as to afford equal facilities to them all. A ship constructed on this principle would experience the least possible amount of friction, and possess a form well adapted for causing little disturbance. Lord Robert Montagu, however, does not give the practical information necessary to carry out his theory. He does not describe what must be the nature of the curve of the dividing lines as shewn in the sheer plan; and without knowing this, and consequently the height at which they cut the midship section, the timbers cannot be drawn so as to cross at right angles a series of practically useful dividing lines, which I can conceive to mean nothing else but a series of lines which shall be equidistant from each other throughout their whole length. In his explanation of this principle there are, however, several very important points suggested for consideration; and on account of my inability to do justice to them I must refer my reader to the book itself.

The system (if such it can be called) upon which the ends of most yachts are designed is that of imitation. They are either made like those of some other yacht, or nearly like them. They are either an improvement upon some others, or certain parts of them are modified to make their adaptation to some particular purpose more perfect. The errors generated by this process are quite incalculable. For when it is considered how many different parts of the ship tend to produce any one quality, in fact how everything about the form, rig, and equipment of a ship, tends in some measure to the production of each, then it is obvious how fallacious must be the deductions which are obtained from comparing anything less than the whole of one ship with the whole of another. To produce a difference in the degree of prominence of any one quality, the whole design will most likely require to be altered; and whether this is done or not, it is experience alone that dictates the alteration.

One of the few points on which nearly all yacht-builders agree, is the form of that part of the after-body which is above the load water-line. In nearly every yacht the general characteristics of this part are alike;—the deck is nearly as broad at the stern as it is at the midship section, and this, with the upper part of the sides supporting it, is made to end in an overhanging counter. Although this latter appendage is sanctioned by universal consent, yet there appear to me to be evils of such a serious nature resulting from it, as to demand critical attention. In the first place it is a great weight situated where the vessel should be kept as light as possible; and a greater fault than this can hardly be imagined. What yachtsman would think of stowing some hundredweight of ballast far aft in the run of his vessel! Yet this is what is done in an exaggerated form by building a counter on to the stern of her. In an eight-tonner it weighs about the same as a good-sized dining room table; and in large yachts it may be compared in weight to a farmer's waggon; and these are carried, not in the hull, where at any rate there would be some support under them, but projecting beyond the stern. This certainly is the camel that is swallowed while straining at such gnats as a heavy tiller or stern lockers. To a man with any mechanical sensibility, a counter must needs be an eyesore; for its construction is necessarily weak; and the end of a ship is of all others the place where strength is important. The bows are strong by construction; leaving out of the question the quality of the materials, their form is adapted for strength. But a counter possesses no such attribute, and depends entirely upon the tenacity of its ill-disposed materials. The objects of the counter are:—to increase the deck room, and to improve the appearance of the vessel. The first of them is obviously gained, but the value of this extra piece of deck is usually over-estimated. In large yachts it is quite unnecessary; and in small ones it is nearly useless. The deck of a little yacht is too small to walk about on; and even to sit on it, in the absence of a high bulwark, is dangerous. The cockpit is the place where all the work of the boat is carried on; and there, too, is the place for the passengers to sit. The only use of the deck-room gained by a counter in either large or small yachts, is that it affords a standing-place for the crew when tying the reef-points near the end of the boom; but to have the boom of such a length that the end of it cannot be got at from the hull of the vessel, is a poor reason for incurring the disadvantages consequent upon having a staging carried out under it. The improvement to the appearance which is attributed to the counter seems to lie in the lengthening of the line of the sheer, and in its general tendency to make the vessel look larger than she really is; but the admiration of such characteristics as these must be traced rather to habit, than to a just sense of beauty.

There is an impression prevalent amongst yachtsmen, that a counter performs the important function of lifting a vessel to a following sea, and saving her from being pooped: a notion that has the credit of some antiquity, besides almost universal acceptance; yet which a close examination will, I believe, completely dissipate. Until the counter is immersed, it is of course an encumbrance rather than otherwise, but when the following wave reaches it and rises to the taffrail, it is yet insufficient in bulk to buoy up the whole ship, and must be helplessly buried, involving perhaps the danger of foundering; whereas, if the after end had been carried down below water instead of being hoisted in the air without support, the wave would have floated her up with the same certainty and safety as if it had approached her at the bows.

This I conceive to be a correct account of the alternative effects of the two sorts of sterns, and the argument clearly is all against the counter. That is to say, the disadvantages to sea-going qualities consequent on its weight and position, exceed beyond comparison the trifling gains in respect of deck-room and appearance.

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CHAPTER IV.

ON SOME OF THE PRINCIPAL ELEMENTS OF GOOD DESIGN.

IT is evident that theoretically a vessel may be faultless under certain given conditions; but as the circumstances are in practice infinitely varied, the success attained in one direction will often involve failure in another; and it becomes the business of the designer to determine in the first place what particular qualities will be most frequently and urgently in demand; and in the next, how they can be severally attained without interfering with or neutralizing each other. If, for example, weatherliness and light draught are considered of pre-eminent importance in the proposed vessel, the draughtsman will have to decide how far he may venture to lengthen his ship with the view of compensating for the curtailment of depth; since weatherliness is largely dependent on the area of the vertical longitudinal section.

The fewer the number of conditions proposed, the more perfectly may they be met, since all of them call for compromise; and if many desirable qualities are abandoned, the remaining ones may be attained in great perfection, and in this way we may construct satisfactorily a racer, a trader, or a life-boat. But the design of a good yacht involves more complicated problems, for success in this requires that her performance shall under no circumstances be bad. She must in the first place possess speed and good sea-going qualities. These are absolutely necessary; and probably the most insinuating of all those claims which can only be indulged at their expense is that of internal accommodation. It is only the very experienced yachtsman who fully recognises the fact that a small craft can only afford small conveniences, and few of them, and the consequence is that in nine cases out of ten the vessel is sacrificed to her cabins. The want of constructive ingenuity, however, is nowhere exhibited in such a striking way as in the disposition of what little space there is in most yachts; but this is a subject of which I shall have to speak more particularly in another chapter, and I will only remark in passing that the accommodation afforded by any craft, depends much more on arrangement than on mere space. The two leading qualities, however, of speed and sea-going ability, when admitted to be of paramount importance, are not always apportioned with due regard to their relative value, the latter being too often sacrificed to the former. To a considerable extent each is dependent on the other, and either property sought in extreme is liable to result in complete failure through the suppression of the other; and any disproportion of this kind, even when far short of failure, must seriously curtail the serviceableness of the yacht.

This general excellence should always be the first object of the builder, and there is no characteristic so conducive to it as balance. A ship's hull should be a beautifully symmetrical structure; and it is a remarkable fact that in shipbuilding admirable performance and beauty of appearance go hand in hand. The most ignorant person will readily perceive the necessity that both sides of a vessel should be alike; and it is only in some semi-barbarous craft intended to act under very peculiar and unvarying circumstances, that this rule has ever been deviated from. This, however, has hitherto been the only respect in which the principle of natural balance has been duly recognized. It is curious that skilful shipbuilders should be content to get the ends of their model out of all proportion to one another; so that it is by no means an uncommon thing to hear of vessels that poke their heads into seas, vessels that run off their helm, vessels that require their masts shifted, or their ballast shifted, or that are somehow uneasy and unmanageable in water above a certain mild degree of roughness. It does not appear to have been recognized that all these and other faults are the inevitable consequence of want of normal balance.

If the bows of a vessel are made long and fine by placing the greatest breadth abaft the centre, then the more buoyant after body can only be sunk to its proper level by placing the centre of the ballast some way abaft the centre of buoyancy; and thus an artificial balance is established. Under these circumstances, the forces at work on the vessel, the wind and the waves, are encountered by her two ends on different terms. The forward end presenting the longest leverage, invariably gives way before the least unusual pressure, no matter what its nature or direction, while the after end always offers a comparatively stubborn resistance. And if the after body of the vessel is not only shorter but also fuller than the fore body, then the lateral resistance of that part is, on account of the form of the ship's bottom, less effective; but this is compensated by increased draught at that part; and thus the forward and after areas are made to balance each other in spite of the inequality of their leverage.

Under these circumstances it is actually impossible to discover the exact centre of the lateral resistance, owing to the differing shapes of the two ends of the vessel. An approximation to it is the most that can be hoped for, and so the proper position of the masts, and the shape and size of the sails can be but guessed at; for it is on the position of the centre of lateral resistance that these mainly depend.

All this complication, with its obviously unsatisfactory results, can be removed by placing the greatest breadth in the centre of the vessel, and making the two ends exactly alike. The empty hull of a vessel constructed after this method would naturally float on an even keel; and if afterwards, when she was rigged and ballasted, she still maintained that position, then the centre of all these weights would be exactly in the same vertical as the centre of buoyancy; and a uniformity of behaviour would be ensured, which would alone make her an able and obedient vessel. At the same time the centre of lateral resistance would be known to be equidistant from either end, and consequently it would be easy to place the masts, and proportion the sails so that the centre of their effort should be exactly over it; and thus make the whole a perfectly balanced ship.

The principal objection to this symmetrical form is that it does not afford such large cabins or deck-room as the orthodox form with the full quarters. But in a twenty-tonner there will be accommodation for the owner and his two friends besides the crew of two men; and as a rule, in yachts of all sizes, one friend to every ten tons is a fair allowance. As far, however, as the cultivation of the art of sailing is concerned, the smallest decked vessel is not only as good as, but much better than the largest; and the science of Naval Architecture may be equally well exemplified; and the man who is really able to appreciate these latter aims will never for a moment allow them to be interfered with by any other consideration.

It is generally supposed that the less displacement a vessel has, the more easily she can be moved; and therefore to reduce the displacement, so long as the lateral resistance and stability are preserved, is always considered desirable; and as these two latter qualities are dependent upon a certain degree of depth and breadth, the usual way to reduce the displacement, while maintaining them intact, is to make the transverse sections concave, from the bilge to the garboard. This method, besides reducing the displacement, increases the stability by form; for there is a greater difference between the upper and lower areas of the hull. The lateral resistance, too, is increased, for the concave surface of the side meets more obstruction by the compression of the water within its concavity, than it would do if it were straight or convex.

There is, however, one insuperable objection to this simple mode of obtaining small displacement with sufficient stability and lateral resistance; namely, that the dividing lines, or those lines along which the water moves in passing the ship's bottom, will have to converge as they approach the midship section; by which means the water must be condensed at that part, as if it were being forced through a horn or conical tube, which will necessarily absorb some of the force which we wish to economise and apply to the sole purpose of driving the vessel ahead.

There is only one other way of reducing the displacement below; and that is to put the required amount of buoyancy in the form of a shallow hull, and obtain the lateral resistance by means of a keel of the required depth. In the shallow hull the dividing lines may be made without any convergence in any part of them, as the displacement is already sufficiently reduced; and the keel being as thin as strength will permit, its displacement in comparison with its lateral resistance will be the smallest possible. The penning up of the water under the ship's bottom is, however, the inevitable result of reducing the displacement in an irregular manner, that is, in any other way than by reducing the size of the vessel either in breadth or depth.

The advantages of this reduction are, however, most important and obvious; and it is only when its more subtle contingent evils are overlooked, that harm accrues; and then it is, that in a blind striving to reduce the displacement, the very worst class of yachts are produced.

The advantages of the shallow hull and deep keel form are considerably lessened by the reduction in stability which is consequent upon the short leverage possessed by the ballast which is stowed inside the ship; and if the keel cannot be converted into ballast by making it of heavy material or by weighting it, then this loss of stability must be made up for by increasing the beam of the vessel, thus entailing the loss of that speed which was gained by the reduction of the displacement below. The possibility of ballasting a keel therefore becomes the question which must first be answered; and then the capability of affording stability being known, the relative values of reduced displacement and good lines becomes a less complicated question.

A wooden keel, unless it is built of some exceptionally heavy wood, will be of less specific gravity than the water it will displace, and therefore will entail more ballast than would be necessary to sink the hull to its load water line without it; and this extra ballast in no way adds to the stability, for it is located above the buoyancy it counteracts. This buoyancy of the keel cannot be reduced below a certain amount, because considerable thickness is necessary to prevent its crumpling up with the weight of the vessel when she is hauled up for cleaning or repairs. An unballasted keel is therefore all instability. But any keel can be ballasted sufficiently to overcome this fault; although the capability of carrying effective ballast decreases in proportion as the depth of the keel increases. It must be kept thin, or its object—that of obtaining lateral resistance with small displacement,—would be defeated; and therefore the deeper it is made, the weaker it becomes, and the less capable of holding any weights put into it. These two causes—the weak construction of deep keels, and the great leverage of the ballast in them,—place a very narrow limit to their practicability. The tenacity of small pieces of wood being greater in proportion than that of large pieces, very small yachts will be able to carry nearly all their ballast in a deep keel. In larger vessels a proportionate amount cannot be applied in that way, but must be carried inside the timbers of the ship. This leads directly to the inference that large, and small yachts must be constructed on different systems: the little ones with shallow hulls and deep keels, and the big ones with great displacement. These two classes may of course merge into one another, but still the larger yachts will be slower in proportion to their size than the little ones. Small yachts can avail themselves of the best form,—shallow hull and deep keel, which permits of good lines without loss of stability; and there only remains to be answered the simple question whether big yachts should be made of good shape and large displacement, or with small displacement and bad shape.

By the reduction of the displacement the lines are evidently damaged, whereas, if the form is left full, it admits of their being drawn in the direction most favourable to easy progress. The conclusion may therefore be fairly drawn that if there is no other good or bad quality arising out of the great or little displacement, it matters not whether it is, or is not reduced by making the hull concave from the bilge to the garboard. Besides the reduction of the displacement (the primary object) and the bad form engendered thereby, the effect of this concavity is appreciable in some other respects: the lateral resistance is increased, but the momentum of the vessel is reduced. The amount of stability, however, remains practically unaltered; for although the form is essentially a more stable one, yet as the ballast has to be reduced along with the displacement, the gain is probably counterbalanced. The result on the whole is, therefore, that the lean ship will have the advantage of better lateral resistance, while the full-bottomed vessel will possess superior momentum. In this latter characteristic lies the chief advantage which large yachts always possess over small ones. The resistance to the onward movement of any vessel is temporarily increased by every wave she encounters; and her progress is consequently a series of steps and stoppages. These are more or less pronounced in proportion to the roughness of the sea or lightness of the vessel, and it is therefore in mitigating them that momentum is of use. In perfectly smooth water there is, of course, no occasion for it; but as calms make sailing impossible, this exception counts for nothing, and the possession of superior weight is always an advantage. This applies in whatever direction the vessel is sailing: while lateral resistance, on the contrary, is useless when going free, and a slight increase of it is only appreciable when the vessel is close-hauled.

As any such modification in the form of the ship's bottom as that which I have described, carries with it no advantage in point of abstract speed, while it reduces the momentum and the reliable nature of the stability, and only slightly increases the lateral resistance, the conclusion is inevitable that a good form is more valuable than a reduced displacement. Or in other words, the qualities developed by full dividing lines are more serviceable than those resulting from a concavity between the bilge and the garboard.

This is applicable to all yachts without exception; yet as small yachts are not required to sail in such rough water as large ones, and as we dare not sacrifice their buoyancy to any other consideration, then reduced momentum may be accepted as the lesser of two evils; and speed must be sought for them in the shallow hull and deep keel form which permits of reduced displacement while retaining parallel dividing lines.

Common unballasted keels which are only made sufficiently deep and thick to give the required strength to the vessel, possess other properties which it is desirable to notice. That part which is below the garboard adds considerably to the lateral resistance; not merely by the extent of the surface it presents, but also by the effective angle at which it presents that surface; for it is always in a more nearly perpendicular position than any other part of the ship's lee side, and so more nearly at right-angles to sideway movement. The supposition that a keel will enable a vessel to sail with less list than she would without it is erroneous. Against a momentary pressure it would doubtless maintain the position it happened to be in, whether the ship were listed or upright, for its surface presents a very effective angle to the mass of surrounding water; and so to move the keel suddenly, several tons of water must be moved too, which would take time, therefore the momentary pressure would pass, and the position remain unaltered. But as in practice no pressure on the sails, however sudden, can subside instantly, such resistance as a keel can afford is futile, and when once moved it will lie as well at one angle as another, and will not add in the least degree to the vessel's ability to stand up to her canvas. If the pressure of the wind is sufficient to make her careen twenty degrees, she will do so whether she has a keel or not, but with it she will be a few seconds longer before she arrives at that angle: and if the squall were sufficient to capsize her, that catastrophe would only be slightly delayed by a keel. It is very effective, however, in counteracting the rolling consequent on the pendulous motion of a ship; but in vessels rigged and ballasted as yachts are this is almost an unknown fault; and therefore to mitigate it must not be considered the especial function of keels. By saying that rolling is an unknown fault in yachts I must be understood to allude to that oscillation on the centre which is simply a pendulous motion, and not to the rolling caused by the stable form of the vessel keeping her with her proper part immersed, although the surface of the water assumes constantly varying angles to the horizontal. This rolling, which occurs while lying in the trough of a swell, is the result of stability by form, and would be rather increased by a keel than prevented. It is to this motion that reference is made in the paradoxical saying of seafaring men, that very beamy ships are uneasy in a sea way; they are, in fact, too lively—a characteristic very trying to their spars. The reverse of this would be a case in which (if it were possible) a ship possessed no stability by form, but depended entirely on ballast. This vessel, although lying in the trough of the sea without any wind to steady her, would not roll; for, there being no stability by form to make the ship's position conform to the surface of the water, the ballast would keep her perpendicular.

Lateral resistance is therefore the only useful property that ordinary keels possess besides effecting their primary object of strengthening the ship.

The stem, which may be said to be a continuation of the keel, often has fictitious qualities assigned to the different angles to the perpendicular at which it may be placed. An upright stem is thought to cut through the water, while a slanting one is imagined to glide over it. These fancies are in some measure the result of what does take place in different vessels constructed with different-shaped bows; those with perpendicular stems generally being more knife-shaped; and those with slanting stems generally being more after the spoon form; but as either of these forms of bow may be made to end in either shaped stem, it by no means follows that particular qualities should be attributed to it; for the stem itself does not tend to these results in any appreciable degree. If it were desirable to reduce the lateral resistance at the fore end of the vessel, then the slanting stem would possess the advantage over an upright one, that the reduction could be made where it was most wanted, and without involving the result in the uncertainty that would accrue from reducing the draught forward. A slanting stem is supposed to ease the pitching of a vessel, for the reason that, as her bows plunge into the water, there is an increasing displacement or buoyancy forward, and so the end of the ship is less liable to complete immersion. Yet against this is urged that where the stem slants away from under the head of the vessel, there remains all its weight unsupported by buoyancy; and the same evils in a less aggravated form may result from it, as were attributed to the counter. The slanting stem is less liable to catch and retain floating seaweed than the perpendicular one. Several such trifling and contradictory qualities may be traced to each; but perhaps there is no one of more importance than the appearance. Where the masts of a yacht rake, the bowsprit to be in harmony with them should have a steave; and then for the same reason a slanting stem looks graceful; and when the mast or masts are upright, then a horizontal bowsprit and upright stem are more consistent. Against either nothing can be said on the score of good construction, for both are, practically speaking, equally strong.

The position of the stern-post in relation to the perpendicular, is rather more important than that of the stem; for besides the control it exercises over the form of that part of the hull which is near it, the position of the rudder is entirely dependent upon it. Now that the length for tonnage is no longer measured on the keel, the chief inducement for the adoption of the raking stern-post is wanting, and the remaining peculiarities resulting from it are of but doubtful value. To rake a stern-post is to reduce the lateral resistance at the end of the vessel, and if the stem is slanting also, then the immersed part of the ship is shortened, and will turn more quickly than if it were longer. A long ship shortened in this way, will possess the advantage common to any short one, namely, that of being quick in stays; but she will at the same time incur the disadvantage from which the normally short vessel is free, of having an unnecessarily large portion of hull out of the water, which, from its position at the ends of the vessel, will be seldom immersed, and is therefore so much unnecessary top hamper, rendering the ends heavy, and the vessel on the whole cranker than she would be without it. The conclusive argument, however, against a raking stern-post compared with an upright one, is that with the latter the same amount of lateral resistance can be obtained with less draught of water.

As the position of the rudder is determined by that of the stern-post, the latter must be governed to a great extent by the exigencies of the former; for an efficient rudder is a requisite of the first importance. When the slanting rudder is put over to one side, it has a tendency to dive, or drag the ship's stern down, and this lifts the bows; the remainder of the force which it is capable of exercising is directed to turning the ship round. If the stern-post is placed at an angle of forty-five degrees to the perpendicular, and the rudder put over to an angle of ninety degrees to the keel, then exactly half its power is devoted to lifting and half to turning; and as the inclination of the stern-post decreases and approaches the perpendicular, so the lifting power of the rudder is decreased and the turning increased, until the perpendicular is arrived at, and then all the force of the rudder goes to turn the vessel. The effect of depressing the stern and lifting the bows when altering the direction of the ship's course, is not, as may be imagined, to render her easier to turn; for neither the whole displacement, the lateral resistance, nor the length of the water lines are in any way reduced, but that she will turn on her heel instead of on her centre. The after part of the ship being somewhat depressed remains comparatively stationary, while her head comes round. It follows then that a great part of the slanting rudder's force being devoted, not to turning the ship, but to making her turn on a particular pivot, that its efficacy is reduced according to the angle to the perpendicular at which it hangs; and it must therefore either be larger than the upright one, or it must be put over to a greater angle to produce an equal effect; either of which amounts to so much more stoppage of the ship's way. Apart from the question of turning the ship, it is urged for a slanting rudder that it will, from its hanging position, rest quiet when the vessel is at anchor. This amounts to saying that it is difficult to move; and so it proves; for whenever the tiller is put to one side, the weight of the rudder has to be lifted up; and this, with its necessarily increased size, calls for the exercise of considerable strength to steer the vessel, which, besides the strain upon the rudder head, is in itself a decided disadvantage, and one that is certainly not counterbalanced by the stillness of the hanging rudder when there is no way on the ship.

Drag, or greater draught of water aft than forward, is a peculiarity which, like the raking stem and stern post, possesses no property sufficiently useful in itself to warrant its adoption. It produces several qualities which are cherished by its advocates as important, but which appear to me very weakly supported by argument. It allows a deeper rudder; it facilitates a vessel's turning on a pivot far abaft her centre; and in conjunction with the practice of keeping the greatest breadth well aft, it is said to make her take the shock of waves striking her bows more easily.

The attainment of neither of these qualities is, however, the primary object of the drag; for it has for its original purpose the mitigation of an otherwise unavoidable evil, the source of which may be said to lie in the want of harmony throughout the whole design: first, the two ends of the ship are made out of all proportion to one another, by putting the after end of a large, roomy, and buoyant vessel on to the bows of a small, fine one; and so the good speed of the fore end is neutralized by the bulkiness of the stern; and as she must be made to go fast, enormous sails must be carried, which entail increased disproportion; for the mast being big, it cannot be carried by the little ship that goes first, and must therefore be placed nearly in the middle; and consequently the boom must project a long way over the stern, which ends in locating the centre of effort of an enormous sail a long way abaft the natural centre of lateral resistance. To prevent the vessel from twisting round with this unequal pressure, the first disproportion between the two ends is increased, by increasing the draught aft. Thus one evil begets another, for this drag is in itself an evil. It greatly increases the draught of water, without proportionately increasing the lateral resistance; and as deep draught is an inconvenience only tolerated because of the eminent importance of turning well to windward, any addition to depth not entirely devoted to the achievement of this object, is an inexcusable waste of power. It is curing an evil that never should have existed at the expense of a quality of singular value.

This inconvenience is more felt in small yachts than in large ones. The big ones either have a pilot on board when they enter a river or harbour, or they remain in the open sea, in either of which cases the drawing a foot or two more or less water would not be of much consequence; but the little yachts expect to go in anywhere and everywhere, and if they cannot they are comparatively useless and unsafe. A man in an eight-tonner should have every advantage that is to be derived from as shallow a draught as is compatible with the other essential qualities. He should be able to make a short cut over a sand-bank, or take refuge even in very shallow creeks and inlets; but if he cannot do so because his vessel possesses the quality of sailing pretty straight, gained by a considerable drag (preventing her from being twisted round by her ill-disposed sails), her straight sailing is but poor consolation; and he may fairly infer that there is something wrong in the design. In our fashionable model, where the after end is made full, and the fore end fine, and enormous sails with projecting booms are necessary, the drag is unavoidable; and to abolish it alone, would only make bad matters worse.

The contingent qualities attributed to the drag—those of rendering a vessel easy in a seaway, and able to turn upon her heel,—may be otherwise described as a great tendency to yaw about, rendering her very difficult to steer. And the increased depth of rudder consequent upon the drag, is, in any fairly-proportioned ship, quite unnecessary. Very shallow boats certainly are liable to lift their rudders out of water; but such are only adapted to harbour-sailing, and are not fit for rough seas.

The entire freeboard of a yacht should be so high that she may not take in the water over the lee-rail; and although of course it is impossible to keep all waves from breaking on board of her, yet the sides should by their height afford some protection in this respect. For these purposes one shape would do as well as another, but as the freeboard is subject to frequent immersion, the adaptability of its form to speed must not be overlooked. The actual height to which it should be carried depends in every case upon the size of the yacht, for it does not bear a fixed proportion to the depth and breadth, and small yachts must have comparatively higher sides than large ones. The smaller the vessel, the more liable she is to be swamped; and therefore the drawbacks which attend high sides must be endured, in order that she may have more spare buoyancy to meet the greater risk of shipping seas, and means provided to keep them out as long as possible.

There are two very opposite qualities possessed by this upper part of the hull. Any part of it which is out of water is top-hamper, and, as such, tends in no inconsiderable degree to make the ship crank; but when any part of it is immersed, it becomes so much buoyancy, and helps to make the ship stiff. These are, however, not the special functions of the topsides, but only collateral advantages and disadvantages which pretty well balance one another, and, as such, need not be taken into consideration.

Keeping in mind the special object of the freeboard, together with the great drawback to high sides that they create considerable wind-draught when the yacht is close-hauled, a compromise must be effected.

The only well defined condition is that the sides should be sufficiently high to keep the lee-rail out of water; and this may be considered a reliable guide in determining their height. Anything additional is comfort gained at the expense of weatherliness, at all events.

In estimating the degree to which the vessel will be careened by the wind, allowance must be made for the possibility of her heeling over further under exceptional circumstances; and this margin of extra freeboard must be larger in proportion as the vessel is small; and then if an inclined water-line is drawn at that angle, it will indicate the actual height of the roughtree rail, no matter what the beam of the vessel may be.

Near the stem and stern it is advisable to carry the topsides higher than is deemed necessary amidships; for the smallness of the capacity, and consequently deficient buoyancy, at those parts, renders them much more liable to submersion in an advancing or overtaking wave.

Apart from the height to which the topsides shall be carried, almost the only particulars in which their designer can exercise his judgment, are the amount of tumble-home and flare that may be given to the different parts. The practical efficacy of these either in promoting speed or safety is inconsiderable; but in rendering the deck more convenient, and the whole appearance of the ship more beautiful they are of great value. If the upper part of the freeboard is flared at the bows, the deck room is increased there, and the spare buoyancy of that part is made of a more reliable size than if the sides were carried straight up; and both these advantages are gained with but very little increase of weight. If the sides amidships are made to tumble home, there is a slight decrease in the tophamper, which is of small value; but by this form the curves which the timbers must take at the bilge can be made a more beautiful shape; and any unavoidable knuckle which will come there, can be made less pronounced; and the box or coffin-shape suggested by it, can be replaced by the cup-shape, which is not only suggestive of, but also conducive to, that important quality in a yacht—that she should be water-tight; and the vessel looks at once strong, comfortable, and seaworthy.

If tumble-home were carried to a considerable extent it would doubtless be of good practical value by reducing the crankness resulting from top-hamper; but to do this in a yacht is impossible, because the more the sides are made to tumble home, the more the spare buoyancy is decreased; and as the sides are only carried sufficiently high to obtain the necessary amount of this, to reduce it by considerable tumble-home, would only be cutting off in one direction what must be added in another. In the case of old men-of-war, where high sides were necessary to carry several tiers of guns, then—spare buoyancy not being the object,—considerable tumble-home greatly reduced their crankness, without impairing the usefulness of the sides as supports to the gun-decks.

In speaking of the height and shape of the freeboard of yachts, all that part of the side which is between the water line and the rough-tree rail is included; and how much of this is devoted to bulwarks depends upon the following considerations.

It is desirable that the space below the deck—the really reliable buoyancy,—should be capable of supporting any such quantity of water as may possibly effect a lodgment above it; and to this end the space between the deck and the water-line should be larger than that included within the bulwarks. When, however, the yacht is so small that with a useful bulwark, the remaining space below the deck is not sufficiently large in proportion to that above it, then the deck must be raised very nearly to the top, and the shelter for the crew and passengers must be provided by a deep hole or cockpit.

The deck should be raised very nearly to the top of the freeboard, but not quite; for although a low bulwark or ledge has the disadvantage of holding some of the water which may be shipped, yet its advantages more than counterbalance this. Although most of the falls of the running rigging in a vessel of this size may be brought into the cockpit, yet there are some of them which can hardly be so effectively used as if made fast on deck; and besides attending to these, there are other duties which often require to be performed there, and it is then that a ledge is of the utmost value. It will not prevent a man's falling overboard, but when his foot is placed against it he cannot *slip* overboard; and on a wet deck, in a rough sea, without some kind of ledge, this would be the accident most likely to happen. In fact, without a firm foothold an amateur sailor is helpless while standing on the deck of a small yacht in bad weather; and to avoid this disagreeable predicament, a small part of the reliable buoyancy must be sacrificed, by placing the deck a little below the top of the freeboard. And this plan must be adopted in all small yachts, until their size will allow of having good high bulwarks, without dangerously reducing the space between the deck and the water-line. Bulwarks that are less than two feet and a-half high, are not of much use for protection; and if they cannot be as high as that, it is far better to concentrate the shelter into one roomy and comfortable cockpit. A compromise between these two plans, is to retain a low bulwark, abolish the cockpit, and raise a handrail or rope on stanchions all round the vessel. This is transferring all the comfort from the deck to the cabin; for the latter may in this way be much more spacious; but on deck there will be, even if the handrope affords actual safety, no comfort. It is impossible to seek, with any degree of success, shelter under the lee of the weather handrope; while down to leeward there is anything but the appearance of safety.

The height of the freeboard being greater at the bows than anywhere else, if the deck is laid nearly level, there will be a higher bulwark or ledge near the stem than elsewhere; and this is a most desirable arrangement; for the most difficult operations are performed in the eyes of the vessel, where the deck is very narrow—shifting jibs, for instance, in a rough sea,—and increased height of bulwarks renders what would otherwise be a hazardous undertaking quite a safe and easy one.

The foregoing critical observations include most of those details that are of importance in yachts adapted for constant use, and whose performance must be uniformly good under all ordinary circumstances.

The performance of a yacht may, however, not be required to be characterised by this uniformity. She may be intended only for racing or cruising in one sort of weather: to be used only in winter or only in summer; to cruise only in latitudes where the steady trade winds prevail, or for constant knocking about in the stormy North Sea. Her owner may be a man who never wishes to put his own hand to a rope: a man who never weighs his anchor without having on board a stalwart crew of professional seamen; or he may be one who always sails his own boat himself and alone. Such peculiar requirements as these, and numbers of others, will necessitate a somewhat different value to be set on nearly every characteristic, even down to the very fastenings in the keel. And to construct a yacht to answer such special purposes, the designer must not only alter one or two of the proportions which exist in the uniformly good yacht, but all of them; or the result will be unsymmetrical, and generally unsatisfactory.

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CHAPTER V.

SAILS.

IN making the drawings for the sails of a yacht, the chief points which present themselves for consideration are their size and position. When the vessel is sailing with the wind abaft the beam, their size only is of consequence; but when the wind is before the beam, then their position becomes of the utmost importance; and this is the point that must first be settled. In the latter case the wind strikes the sail obliquely, and is equivalent to two forces,—one acting at right angles, and the other parallel to the surface of the sail. The latter produces no appreciable effect; and the only pressure the sail sustains is that portion of the oblique force, which, when it is resolved or analyzed, takes effect in a direction perpendicular to its surface. As the obliquity of the wind to the sail increases, so the amount of this perpendicular pressure decreases; and it must be clearly understood that at whatever angle the sail is set to the wind, it is only the pressure which is perpendicular to its plane which is utilized; and although this is spread over its whole surface, yet its effect on the ship is just the same as if it were applied at one point only; and this point is technically called the centre of effort. There is a further modification of the motive power dependent on the position of the vessel's hull in relation to it; for when she is sailing on a wind, the force which is transmitted by the sails to the hull, acts obliquely to the line of the keel, and may also be resolved into two component parts,—one perpendicular, and the other parallel to the ship's course; the proportions these bear to one another varying with the angle at which the sail is set to the keel. Here both the resolved portions are effective, the one perpendicular to the plane of the keel drives the vessel to leeward, while that parallel to it pushes her onwards. It is desirable that the former of these two (the leewardly pressure) should be completely neutralized by the resistance offered by the ship's side; and to effect this without in any way altering the direction of the vessel's course, it is necessary that the centre of effort of the sail, where this lateral pressure is exerted, should be exactly over the centre of the lateral resistance. It is impossible, however, for the position of these two centres to be maintained always in the same relation to each other; for every time the trim of the sail is altered, the position of its centre of effort is shifted either forward or aft. But as the lateral pressure is greatest in proportion to the forward pressure when the sail is set at a small angle to the keel (close-hauled) it is in this position that it is most important that the centre of effort should be exactly over the centre of lateral resistance.

These are the principles from which the situation of a sail must be determined; but its size depends upon other considerations.

I have before alluded to the usual methods of rigging yachts, and pointed to the conclusion that a large sail at the end of a short lever, and a smaller sail at the end of a long lever, although they would balance one another when the vessel was sailing in a smooth sea, would be very liable to produce an irregular effect upon her if she were unevenly supported, as she would be in rough water. This disposition of the sails is, however, almost universally adopted, and its evil consequences are traceable in nearly all yachts to a greater or less degree. The apparently simple remedy for this is to shift the position of the sails; but if other conditions remain unaltered that is impossible. For instance, if the mast of a cutter is shifted forward from its average position of one third the ship's length from the bows sufficiently to situate the centre of effort of the mainsail over the centre of lateral resistance, it must be made shorter and thinner; for its original weight could not be so well carried in any other than the orthodox place, unless the design of the hull were altered. Or, if in a schooner the foremast were placed so that the centre of effort of that sail were over the centre of lateral resistance, then the whole amount of canvas would be reduced, for the mainsail would have to be shifted further aft, and its consequent diminution could not be made up for by the head sails without destroying the balance. Or if the foremast were not shifted, but the size of it and its sail increased till the centre of its effort was correctly placed, then she would become a yawl; but her model must be altered, or the large heavy mast in her bows would be too much for her. Thus it is obvious that to improve the position of the sails, at least one of two things must be done: either the spread of canvas must be reduced, or the hulls must be remodelled. I have already advocated the latter alternative, but only on the grounds of sea-going capabilities, and I may here point out how the sails would be affected by it.

On account of the very considerable weight of a yacht's mast, whether it be large or small, it can only be carried at a limited distance from the chief support, which is the centre of buoyancy; and thus it is evident that in two yachts which were equally stiff, the one whose centre of buoyancy was in the middle of the vessel would be able to carry her mast further forward, and so set her sail in a better place than the one whose greatest breadth was further aft. I conceive, however, that reduction in the quantity of canvas is also highly desirable; for, as every peculiarity of form which is especially adapted to enable a vessel to carry large sails, *also* makes her less easy to move, surely it would be wiser to design a hull out of which the speed can be taken by small sails, rather than one whose merit is the ability to carry large ones.

Concentration of sail is most desirable; and to obtain this, the mainsail of a yacht should be of such a size as to perform the chief part of her propulsion. It must, however, be handy, and to be thoroughly so, it should be (as in a yawl) entirely in board.

In order to avoid as much as possible the stoppage of the vessel's way by the use of the rudder, the sails should afford both facility of turning, and the power of sailing straight. To effect these objects, a small sail should be set at each end of the ship. These, in addition to their special functions, will perform their share of the propulsion, and consequently make a proportionate call upon the stability of the vessel, which must not be overlooked in apportioning this quality to the hull. The power of these two little sails should exactly balance one another;

and the simplest way to obtain this balance would be to place them both equidistant from the centre of lateral resistance, and make them both of the same size; but as the after leech of a mainsail of the usual form extends somewhat further abaft the centre of its effort than the fore leech does before it, the little sails cannot be placed at equal distances from the centre without removing the foresail to the end of an inconveniently long bowsprit; and therefore to avoid this the head sail must be made somewhat larger than the mizen, that at the end of its shorter lever, its lateral pressure may be equal to that of the smaller mizen with the greater leverage. This disparity is obviously a deviation from sound principles; but the practical amount of harm is rendered unimportant by the smallness of the sails, and their incapability of affecting in this particular way the general behaviour of the vessel. The uses of these two sails will be sufficiently obvious to the practical sailor; but to the uniniated I may point out that if the fore sheet is let go, the pressure of the mizen, being unbalanced by the foresail, will turn the vessel round; and in this way she may be put about, if required, without the help of the rudder at all. Under some circumstances this power of turning the vessel round by her sails may be of priceless value in affording assistance to the rudder; for instance, when clawing off a lee shore, where to miss stays would be to lose the ship. This is an accident that might happen, in spite of the very best seamanship, in consequence of the uncertainty of the wind under high land: the yacht is becalmed just as it is necessary to go about, and the next gust finds her helplessly in irons, and hopelessly doomed to the rocks under her lee. With a little sail at each end of the vessel this could not possibly happen; for if one were trimmed one way, and one the other, she must inevitably turn round, and the properly placed mainsail, whether full or not, will in no way retard the movement. If the foresail and mizen are carefully trimmed, any control by the rudder will be almost superfluous. And if a man is sailing alone he will thoroughly appreciate this capability of going straight; for if he should have occasion to quit the helm, his boat will go on keeping her course, and not turn round and look him in the face directly his hand is off the tiller, and require to be boxed off before he can go on again.

This is a proper application of the yawl rig, and the only variation it is susceptible of is to make the foresail all in one piece or divide it into two, a foresail and jib. Whether this latter is done or not only depends upon the size of the yacht; as in large vessels the head-sail is more handy when divided; and a thick bowsprit and thinner jibboom are together lighter than if made all in one spar.

If the centre of effort of the mainsail is over the centre of lateral resistance, and the two end sails are balanced, then the effort of all the canvas will have its centre directly over that of the lateral resistance; and so far as mere propulsion is concerned, this is the most effective position; but there is a desirable quality which is dependent upon the placing of this centre of effort slightly abaft the centre of lateral resistance. I allude to the quality called weather-helm, and without it in squally weather no fore-and-aft rigged craft is thoroughly safe. It is the tendency to turn her head towards the wind, and her stern from it, under the pressure on her sails, which may be considered a safety valve; for it enables the vessel under any increasing pressure of wind to relieve herself from it by presenting less surface to its action. Its chief efficacy is when sailing with the wind abeam, or anywhere before the beam; for then the increased speed resulting from the increased force of the wind, does not at all relieve her from its pressure, and to turn surely round and present her end to it is a valuable faculty. There is, however, the drawback attached to this tendency that it is all so much loss of speed; for as it is necessary under ordinary circumstances to make the ship go straight, the helm must be constantly kept a-weather, which directly retards progress. This quality must therefore be given with a sparing hand; and the larger the vessel is, the less occasion there will be for it; for big ships are heavier and stronger in proportion to the force of the wind than little ones, and are therefore less often liable to be laid on their beam ends. The tendency to turn round is best obtained by lessening that difference between the size of the foresail and mizen, which exists when they are perfectly balanced; so that when the wind is steady and the weather-helm is a useless hindrance, it may be neutralized by altering the trim of the small sails; and then the speed will only suffer in so much as these are not set exactly at the best angle for propulsion, which of course would be the same as that of the mainsail. In this case there is no alteration in the most effective angle of the chief propelling sail, and there is no direct stoppage by the action of the rudder.

In light winds it is necessary to increase the area of the sails, and when going free it is easy to do this to almost any extent; for all sails that will catch the wind will effect the object equally well, and their position is of little consequence. But when a yacht is on a wind, and it is necessary to increase the spread of canvas, the size, position, and mode of setting the extra sail become as important as those of the mainsail. A gaff-topsail is the only sail of this kind that can be set so as to stand effectively. Its size of course depends upon the lightness of the wind, but its position is dependent upon the point in which the centre of effort of all the sails is required to act. To set a topsail at all in small vessels it must be premised that the wind is steady; and as weather-helm is under these circumstances unnecessary, the position of the topsail should be such as to completely neutralize it, even while all the sails are set at their most effective angle.

The centre of effort of an ordinary working gaff-topsail, such as can be carried on a wind will lie before that of the mainsail; and in making the drawing of this sail, its dimensions, either in hoist or length of head, must be so proportioned that its forward moment may just equal the excess of the after over the forward moment of the three lower sails; so that when this sail is set the centre of effort of all the sails may be exactly over the centre of lateral resistance; when there will be neither lee nor weather helm. When that topsail is taken in and a smaller one set in its place (a jib-headed one for instance) the vessel will have some weather-helm; for although the centre of effort of a jib-headed topsail is further forward than that of a square-headed one, yet from its being a smaller sail its forward moment will be less than that of the other. And as the wind increases, and the small topsail comes down, then the whole allowance of weather-helm is experienced. If, however, the topsail is extended beyond the end of the gaff by a jack yard, then the centre of its effort will be very little before that of the mainsail; but a topsail set in this way can seldom be made to stand well on a wind, and when sailing free it works satisfactorily.

In reducing sail by reefing the mainsail, the position of its centre of effort is shifted forward. This alteration can be somewhat mitigated by raking the mast; but the only effective way to meet it is to reduce the head sail. Here it is evident that the art of design borders on that of seamanship, and though they overlap each other somewhat indefinitely, the use of sails is a matter so well understood that I need not pursue the subject further in that direction.

CHAPTER VI.

WIRE RIGGING.

WIRE rope is now in general use for the standing rigging of yachts; and one is naturally led to infer that it is an improvement upon the hempen material which it has superseded. Such is certainly the opinion of most yachtsmen; and when comparing it with the hemp, they argue that it is much neater; that it holds less wind; that it is lighter, stronger, and cheaper; and that the lanyards seldom require setting up. These arguments, however, admit of dispute; and in the face of the general verdict, some pertinacious and old-fashioned skippers have been known to insist that wire is treacherous; liable to rust and break; that its reputed lightness and cheapness are not worth the consideration claimed for them; but that, on the other hand, its rigidity has ruined the sailing of many a good boat.

From the existence of such opposite views, it is clear, either that the theory of the subject is not well understood, or else there is some difference of aim which is overlooked by the disputants.

The comparative weights, sizes, and prices of the two sorts of rigging for the same vessel may be shortly indicated as follows. Each shroud of a twenty-five ton yacht should be capable of sustaining a breaking strain of six tons. To supply this strength they must be of 4½ inch hemp rope, or if of wire, 2 inch rope will afford the same strength. The shrouds (two on each side) will measure about 26 fathoms; and if made of hemp will weigh together 113 pounds, offer a surface to the wind equal to 19½ square feet, and cost about £3 15*s*. If they are of wire rope, their whole weight will be 91 pounds, they will present a surface of 8⅔ square feet, and cost about £2 15*s*. Thus if wire shrouds are used instead of hemp, there will be a reduction in top-hamper weight of 21 pounds: a reduction of wind-draught equal to 10 or 11 square feet, and

£1 saved in expense. For the sake of simplicity, the shrouds only are taken into consideration; but if all the standing rigging, including the fore stay, the topmast stay and shrouds, the bob stay and bowsprit shrouds, and runner pennants, are also taken into account, the whole saving in these respects will be just about doubled; and it may be pretty accurately put down at 40 pounds in weight, 20 square feet in wind-draught, and 40 shillings in cost. The tophamper thus saved seems a good deal when looked at alone; but when compared to the whole weight of the mast, spars, sails, and gear, it certainly does not show very prominently. It is about equal to a foot more mast head. It is well known, however, that it is only by attention to the minutest detail that perfection can be approached; and, therefore, let the saving of these 40 pounds be valued accordingly. The 20 feet of wind-draught is certainly a more valuable gain; but like the weight, it is somewhat liable to be overrated on superficial inspection; and its real value can of course only be estimated by comparison with the whole surface which catches the wind and tends to hinder the vessel when close-hauled. Has it ever struck the casual observer that the wind-holding surface of the cutter I am speaking of is between two and three hundred square feet! To estimate it accurately is impossible, and besides, it would vary in every example; but in an ordinary racing cutter of twenty-five tons, it would range between the figures just stated. This is what the 20 feet must be compared with; and one's philosophy must be called upon to console one for the meagreness of the gain.

There is, however, such a thing as straining at a gnat and swallowing a camel; and these differences in weight and wind-draught are most unmistakably gnats.

The fact of wire rigging being cheapest, and that it seldom requires setting up, may surely be put out of the question altogether; for it is not to be supposed that a man owning a five-and-twenty tonner cares for the saving of forty shillings in his standing rigging. In fact, where the transaction is not looked at from a commercial point of view, the cost being increased generally enhances the attraction; and as regards setting up the lanyards—the more work a crew have to do, the more industrious they will be. However, the fact remains that money and labour are economized; and thus far all conclusions are more or less in favour of the wire. But there is more to be said, and although it has been spoken and written many a time, yet it has never been considered with the attention it deserves.

The fact that wire rigging is almost inelastic is obvious, but the effect of this rigidity is the point for discussion.

Anything will stretch to some extent if it is only pulled hard enough, and in the case of wire rope, there is a hempen core to it, into which the wire embeds itself, and so it slightly increases in length before it will break. The stretch is, however, inappreciably small, for shrouds once set up taut will hardly require setting up again during a season. The immediate effect is to deprive the mast and bowsprit of all spring; so that they become fixtures which can move as the hull moves, but no otherwise. That this relation between the position of the spars and the hull is maintained to the detriment of several good qualities of the vessel may be shown in a variety of ways. As the wind is a comparatively constant pressure, and the sea offers a constantly varying resistance by reason of the inequalities of its surface, these two forces meet in the hull of the vessel in a series of shocks; and although the cause in this instance lies with the water, yet the effect is just the same as if it were the force of the wind which was applied in a succession of blows and the opposition offered by the water were uniform. Leaving for the moment the peculiar effect of this disposition of forces when applied to the movements of a ship, attention must first be drawn to the fact that there is actual loss of propelling power incurred by this application of it; for it is well known that a force applied in the form of a continuous strain will drive a resisting object further or faster than if it is divided into a series of blows; and if the force is only subdivided sufficiently it will result in nothing but concussion, and the resistance to onward progress will never be overcome at all,—as if a multitude of blacksmiths tried to shunt a railway train by hitting it with sledge hammers. Keeping this in mind as the consequence towards which the irregular pressure tends, the peculiarities of the case in point may be considered; but as these can only be estimated by comparison, it will be well first to imagine the case in which the force and the resistance meet in one uninterrupted pressure. This can be arrived at in two ways; either, both the pressure and the resistance may be steady (as on a nearly calm day), or, if one is unsteady the other may be pliant; or, in other words, there may be a buffer or spring put between them. The intervention of a medium between two forces in no way reduces their amount, but only applies it differently; the practical effect of which is exemplified in the springs of a carriage, which make it easier to draw, or the fly wheel of an engine, which converts the oscillations of the piston into a continuous revolution. Between the wind and the waves, or rather the sails and the hull there is only one way of putting a spring; and that is to allow the mast and spars to exercise their own elasticity unchecked. This state, however, is impossible with racing yachts, for the spars would have to be made of gigantic thickness; shrouds and stays of some sort or another are therefore obviously necessary; and this condition being granted, we arrive at the two cases which can be compared fairly; namely, the spars supported by that rigging (the wire) which renders them completely rigid; and those supported by hemp which permits the exercise of a considerable portion of their natural elasticity.

The movement of the rigid structure must necessarily be the more uneven of the two. Every time she is struck by a wave the shock will be felt from truck to keel; the wind may even be knocked out of the sails, and her progress more or less arrested. The constant repetition of the shock, even if too slight to be perceived in individual instances, will soon be found to have amounted to a serious retardation of speed; besides which, the deck of this vessel will frequently be under water, when it ought to be dry; and from the unyielding nature of the force thrown on the topsides, they are strained, and a leaky ship is the inevitable consequence.

In the hemp-rigged vessels these evils are comparatively unknown. The amount of elasticity in hempen cordage is more considerable than would be imagined from a superficial knowledge of its qualities; and if the shrouds could be made even more elastic, the advantage would hardly be increased, for it is the first part of the stretch that is most valuable, which having, like the fender between the ship's side and the quay, received the blow and changed it into a pressure, allows the two forces to come quietly together. Under these circumstances the steady propelling pressure on the sails is never relaxed, and consequently the progress of the vessel is never seriously checked. In a rough sea she can rise easily over the waves, and her speed will be the fastest that her spread of canvas is capable of producing.

When it is considered that any invention or improvement that would enable a vessel to sail the least degree faster would be hailed with delight and adopted with avidity, it seems strange that so important an advantage as elasticity of rigging should be completely abandoned; and one is led to suspect that there must be something wrong in the theory, or something impossible in its practice. It does not appear, however, that either of these suppositions is admissible. It was long ago known that any increase of pliability in the whole structure of a ship was certain to result in increased speed. It was no fanciful notion, for authentic details of its practice and results may be read in many an exciting passage of the Naval History of this country. Our own men-of-war have, in some notorious instances, when chased by a superior force, resorted to the expedient of sawing through the beams of the vessel, and outsailed the enemy in consequence. This cutting of the beams not only allowed the sides of the vessel to spring in and out, but also gave latitude to the masts, from around which the deck wedges were also knocked out. Instances, too, are on record of small smuggling and privateering craft which, besides adopting these expedients, also cast off the lanyards of the rigging, and carried on with the masts swaying over the side; thus running the imminent risk of carrying away their only chance of escape, for the sake of obtaining the certainty of additional speed while it lasted. These facts not only show that the give-and-take theory is essentially sound, but that it is capable of practical application.

It is unfortunately impossible to register exactly the value of this spring in promoting speed and the other good qualities alluded to; but it will be hardly necessary, as we only wish to know whether it is of more value or less than the reduction in weight and wind-draught which are obtained by the substitution of wire; and on this point it is possible to form a tolerably fair judgment.

The increased wind-draught of the hemp rigging of a five-and-twenty tonner is about equal to that caused by two men standing up on the bulwark. The increased weight of top-hamper would about be equalled by two men coming up from the cabin to the deck. And when we set against this the certainty of always obtaining some increase of speed, and when the water is rough, considerable gain in this way; together with a dry deck, a tight hull, a comfortable cabin, and a durable vessel, it may be confidently affirmed that, on the whole, the ancient material has been too hastily discarded. Its elasticity, when recognized, has been deemed of too insignificant quantity to be worth retaining at the expense of what is termed neatness; whereas true neatness has no reference to the proper sizes of things, but only to the absence of superfluous bulk. An iron ship is certainly thinner, but no neater than a wooden one.

CHAPTER VII.

VERY SMALL YACHTS.

THIS chapter is addressed to those yachtsmen whose means will only allow of their keeping a boat under ten tons measurement, and is intended to suggest to them a few of the more important details in the rig and equipment of these little craft.

The use of a small yacht is to make short cruises, and to allow her owner and his one, or at most two friends, to enjoy the pleasure of sailing only, apart from any consideration of travelling. Sometimes it becomes absolutely necessary to make a passage from one distant port to another; but as a rule such vessels are not meant to afford sleeping accommodation, or to carry pleasure parties; and should never be dangerously distant from a port. Although they cannot be expected to live through long-continued bad weather, yet the man who owns a little yacht should not be prevented by her smallness from running out for an hour or two's cruise, and experiencing the heightened charm of sailing in a rough sea. The duty, however, which is, of all others, peculiarly that of a little yacht, is that she should be always ready. The owner should be able to get her under way within ten minutes of the time he steps on board; or many a chance of a pleasant little cruise will be lost. To meet such peculiar requirements, there are some qualities necessary which would not be desirable in a larger vessel; and there are others which, although valuable in either, are yet of such vital importance to the little one, as to demand special consideration.

It is of the first importance that the boat should be decidedly small, and not so only by comparison with fifty tonners. She should be so small that she can be managed by her owner alone, without help; and this has immense advantages over being a little larger and entailing the necessity of carrying a crew in the form of one man at least. Having a crew on board involves the loss of one's independence; for if he is deserving of his situation he will be a professional seaman, and as such his advice can never be disregarded with impunity; and the pleasure of acting for oneself will be lost. Even if he is so wonderful a man as never to volunteer advice, he cannot help silently criticising the owner's seamanship, and to know that this is always going on, makes one nervous and mistrustful of one's abilities. If the "crew" is a boy, he will be an exception to the rule if he is not the plague of one's life: never doing what he is told, or doing it so slowly as to worry one while it is doing: never to be found when he is wanted, or dirty and slovenly in his appearance. If he is a superior boy, who understands his business, you are still liable to have to take his advice whenever he likes to offer it, or run the chance of his being able to say "I told you so," when anything goes wrong. These are disagreeables which must be endured during the first few seasons while one is learning to be a yachtsman; but to the passed amateur, a crew on board a boat is a convenience which is hampered with many drawbacks. Let the craft therefore be certainly not more than eight tons, while six tons will be a sufficient size. Next to being small, her hull should be water-tight, and her rig handy. If a boat has to be pumped out every day, it is no wonder that many men should think the trouble too much for the sake of perhaps only an hour's sail; and if the sails take long to set, short cruises would be out of the question. To ensure the whole rig being handy, there must be a careful attention to detail, and everything that tends to facilitate the setting, managing, and stowing of the sails, must be strictly maintained; while all that creates work without assisting the boat in the performance of its duties must be completely excluded. Sail-covers should not form a part of the outfit, for although they make a boat look very neat in an anchorage, yet this cannot compare in value to the time required to put them on and take them off; for it occupies several minutes to cover one's sails neatly; and when sail-covers have first to be unlaced, folded up, and stowed away, it seriously delays setting them. A running bobstay is another contrivance that should find no place in a really handy boat. The labour of heaving it down, and the constant attention necessary to trice it up every time the kedge is thrown over-board, make a superfluous and therefore wearisome demand upon the energies of an amateur; and the bowsprit should either be made to do without it, or a standing bobstay used. The latter is the better plan, as it can easily be cased near the stem with a neat bamboo (before it is shackled on), and then injury to the warp is impossible. The mooring chain will of course always have a parcelling round that part of it which comes in contact with the hull; and when the chain cable is used, it too must be parcelled; which little operation, as it will seldom occur, is infinitely to be preferred to the every day labour of bowsing down a running bobstay. The bowsprit should under any circumstances be so stiff that it will stand without shrouds; for they are very much in the way of getting the anchor overboard or on board, and are practically useless; for the bending of the bowsprit to leeward is not of the least consequence so long as the bobstay prevents its bending upwards. There should be no jib in a craft of this size, but a large foresail set upon hanks on the forestay which should lead to the end of the bowsprit. This is a more effective sail, and comparatively handy; for it obviates all the business of setting a jib, and entails only one pair of head sheets instead of two. To reduce it the lower part may be taken off in the form of a bonnet, a reef earing being always kept rove in the luff; whilst a brail, that admirable but neglected contrivance, may be applied to it with singularly good effect, and the sail thus brought instantly under control in an emergency.

A topmast with all its attendant gear should be abolished, and the topsail sent up on a flying topsail yard. When sailing on a wind this will set a jib-headed topsail perfectly; and when going free its size may be increased by means of a jack yard; and at all times the reduction in the top-hamper is very considerable.

All the sheets in the boat I am speaking of should lead into the cockpit, and be belayed inside the coamings, on either side, within reach of the steersman as he stands at the tiller. The fore sheets should have a single purchase, and lead aft through holes in the coamings. The main sheet should have a double block on the boom, a single one on the horse, and the two falls should lead through quarter-blocks, and thence through holes in the coamings to their respective belaying pins close to the right and left of the steersman. The mizen sheet (if there is one) should have a single purchase, and lead, like the others, into the cockpit. The main-tack tricing line, and the foresail brail should be made fast inside the fore end of the cockpit; and the falls of the two runner tackles also inside the coamings.

The accommodation on board a six-ton boat must necessarily be very narrowly limited, but ought by no means to be very wretched. There is probably no way of destroying all comfort so thoroughly effective as by cramming in too many fittings. The liberty to move is the most rudimentary of all luxuries, and it should not be forgotten that everything we put into the hull is liable to contract it. The room for ingenious contrivance is, however, boundless, and when judiciously ordered the interior of a small yacht is a charming place. The whole of the space will come within these definitions :—forecastle, cabin, cockpit, and after-locker or sail-room. Of these the cockpit is by far the most important. It is constantly in use; while the others are either of secondary importance, or of only occasional value. It should be roomy and convenient, and protected by coamings at least six inches high all round. Any lockers should be in easily accessible places, and not behind seats, or under belaying pins; and these latter should be large, and, where they are near together, should not be placed in a line parallel to the lead of the ropes, but at an angle to it, so that they may lead clear of one another. Next in value to the cockpit is the cabin, if such it can be called in a six-ton boat. The accommodation in this can be very much improved by raising a booby hatch or coach-house over it, which will allow a man to sit upright, where otherwise he would have to crouch very uncomfortably. In adopting this expedient the centre of gravity of the hull will be somewhat raised, and it will look even more top-heavy than it is; besides which the strength of the boat is greatly reduced by the absence of beams throughout that part of her, for almost more inconvenience would be caused by carrying the beams through the cabin, than by an altogether low deck. As, however, this arrangement affords the only comfort attainable in craft of this size, the requisite concessions in strength and beauty become almost inevitable.

Each side of the cabin should be devoted to a broad low seat, with a good horsehair mattress and pillow on each. A part of the space under the couches should be lined with zinc, and contain blankets. The metal lining will keep them tolerably dry, and with two blankets apiece the owner and his friend may pass a very comfortable night, when they are either making a passage, or unable to get home for want of wind. To provide for these, and like occasions, one or two points only need especial attention; but if these are neglected, then to get benighted in one's little yacht is anything but comfortable, and its probability is a serious drawback to pleasant cruising. A compass is of course a necessity; but there is a weak point in nearly all boats' compasses, which is the lighting apparatus at the side. They generally have a very feeble little lamp, which does not half illuminate the dial, and often goes out without any apparent cause. This is the result of the whole lighting apparatus being made too small. Neatness, although very desirable, must not, in the case of a binnacle lamp, be obtained at the expense of so important a quality as light. It should be a large lamp that will burn all night and brilliantly illuminate the face of the compass. With such a binnacle, steering on the darkest night is just as easy as by daylight. A ship's lantern is another important part of the night equipment; for although small craft are not required by law to carry a light, yet when at anchor in a strange harbour, it is obviously essential to safety. The cooking on board a little boat must be limited to the simplest operations, and for this purpose a good spirit lamp is far preferable to any kind of stove. To insure that these three—the binnacle lamp, the boat's lantern, and the cooking and heating lamp,—shall always be in working order, it is important that the wicks and matches should be dry. To keep them in the snuggest and driest place in all the boat will not ensure this if the weather is damp from fog or rain; and there is only one safe place for them that I could ever discover, namely, in one's waistcoat pocket. These little matters may appear trivial to inexperienced persons, but it is only by habitual attention to details that yachting on so small a scale can be made safe and delightful; and if circumstances are favourable, so far as the pleasure of sailing is his object, the yachtsman should never want a bigger ship.

While speaking of the fittings of a small boat, I will remark upon a question which, in connection with the possibility of being caught out in bad weather, constantly suggests itself to the amateur sailor; this is the feasibility of making his yacht, like a life-boat, incapable of being sunk. Possible gales of wind and rough seas are contingencies which always limit, or at any rate should limit, the cruising ground of these little craft to such short distances from their port that they may be able to regain it before the indications of bad weather have time to develope into dangerously strong wind or big waves. A good boat with sound gear, when properly managed, is very difficult to sink; yet if the wind changes and leaves one fifteen miles dead to leeward of one's port, and then increases to a gale, it is impossible to conceal the fact that the position is decidedly perilous. There are chances of surviving it, doubtless, for there is no saying what weather a boat may not live through, provided the presence of mind, skill, and endurance of her crew are equal to the occasion. Many a little trawler exists to illustrate such adventures. But no amateur who is not foolhardy can be insensible to the desirableness of some back door through which he may escape the catastrophe, after all his efforts to avert it have been exhausted: some quality in his boat which—though she is utterly overcome by the wind and waves, every rag of canvas blown away, and her cockpit full of water, shall yet preserve her from total extinction. This quality would depend on her possessing such an amount of indestructible buoyancy as would always ensure her floating, so that she may answer the purpose of a large life-buoy—something for the crew to stick to and hold on by until rescued by some means or other. The question, therefore, becomes a most interesting one, whether or not such an amount of reliable buoyancy can be obtained; and if it can, by what means. If this is shewn to be impossible, it is desirable to ascertain how near an approximation to it is practicable, so that only a proportionate reliance may be placed on it. There is, after all, a limit to the security that would be afforded by any amount of buoyancy, however great; for in extreme cases a boat may roll over and over, or be so constantly drenched by the breaking waves that the powers of human endurance would be worn out, and the people soon perish from exhaustion. To provide against somewhat less trying circumstances, however, is all that we can reasonably expect, and it may be roundly stated that there is but one way to do it; namely, by means of air-tight compartments. Thirty-two cubic feet of air, secured in this way, will enable an ordinary six-ton boat to float when full, with her rail out of water; and a half of this may be conveniently stowed in each end of the hull, where theoretically it is completely out of the way, for nothing heavier ought to be allowed there. Great care is necessary to make this buoyancy thoroughly trustworthy, and some expense is unavoidable. The best way to do it is to shut off as much space as is necessary with bulkheads, and line the compartments with copper; or, in other words, make two air-tight copper boxes to fit the ends of the vessel, and run bulkheads across to keep them in their places, and out of harm's way.

Simple and effective as this plan is, as a mode of ensuring oneself against drowning in bad weather, yet it is seldom adopted. And the explanation is merely that the room cannot be spared. Although every man knows that theoretically the space in the ends of his boat is valueless for stowage, yet unfortunately theory and practice are sadly at variance on this point; and the necessities of the latter always induce one to dispose of spare gear and a thousand and one odd things in those forbidden places. In the stern-sheets or after-locker of nearly every small yacht will be found her spare sails; and down in the forecastle the kedge anchor with its thirty fathoms of warp, the pail, mop, scrubbing brushes, and any new or spare rope there may be on board, the cooking apparatus, and perhaps a life-buoy. These things are to be found in nearly every boat; and if the ends were shut off and hermetically sealed, there would be no place for them but the cockpit, where they would be too much in the way to be endured. All the lockers are wanted for the more delicate instruments—the compass, the lantern, the barometer, the charts, and the telescope; while such things as wine, food, and blankets deserve lockers before mops and pails. This, probably, is the reason why men do not adopt the perfectly practicable plan of putting air-boxes in their boats as a stand-by when all else fails.

There is, however, luckily for those who ever dream of danger, a middle course which, although it does not hold out the hope of salvation in the last extremity that air-tight compartments do, yet by its adoption that extremity may be avoided in, certainly, the generality of cases.

So long as the water can be kept out of the ends of the boat, the process of foundering is a gradual one; and it is the facility of doing this, which renders a partially-decked boat so much safer than an open one. In an open boat, the first little wave-top that breaks over the bows runs all over the bottom of the boat, and is so difficult to get at to bale out, that it goes on increasing till there is a considerable mass. Then as the boat pitches, all the water rushes down to her bows, and pins her down before the approaching waves; and the foundering goes on more rapidly, the water increasing in compound ratio, so that the one man who can be spared to work the bucket is unable to keep her clear, and she fills. In a partially-decked boat this can be avoided by shutting off the ends with two bulkheads. The forecastle and the after-locker or sail-room should be cut off from all communication with the rest of the hull, and approached by hatchways or scuttles in the deck fitted with covers. If these latter are secured during bad weather, nothing but very inconsiderable leakage will find its way through; and all the water which is shipped will lie in the cockpit, and only get as far forward or aft as the bulkheads. These are the bounds between which, come what may, it *must* be kept. The two bulkheads must be carefully fitted into the vessel's shell before the deck is laid. They should be made double, with felt or flannel and white lead laid in between, and the whole fitted against a timber which should have no limber holes under it, but have its junction with the keel and planking well payed all the way round. Although perfectly water-tight bulkheads are, on account of the working of the ship, unattainable, yet the little leakage that will get through if they are well made, will be of no consequence; and even if no steps are taken to free the boat of the water she may ship, the foundering will be a steady and gradual process; while if a man devotes his energies to handling a bucket, she may easily be kept tolerably free.

Besides the bulkheads, this measure of safety involves the necessity of having a pump in each end of the boat; for there will be no limber holes by which the leakage can come to the main pump.

The amount of time an owner has to devote to sailing in no way influences the quality of the pleasure, but only its quantity; and even if his time is very limited—say to an hour a-day or one afternoon a week,—yet, if other circumstances are favourable, he will still be able to enjoy yachting. Of all things which conduce to this desirable end, there is no one so important as a convenient anchorage. In this term are included a host of desiderata, the absence of which has caused many a disappointment, and obliged many a yachtsman to give up sailing. A convenient anchorage is a place where moorings can be laid down which, from the nature of the holding ground, shall never shift, and will therefore be thoroughly trustworthy. And these moorings must be out of the fair-way of steamers, and, from their position, leave little chance of the yacht's being run into by smacks and coasting craft which may be beating in or out of the anchorage. The place must also be sheltered from the wind, so that the water may never be so rough there but that the owner can, in his own punt, board his craft in all weathers. That there should be sufficient depth of water to float his yacht at all times of tide, is a very important point to look to when choosing a place for moorings, or constant disappointments must occur by her being aground when he wants to sail. And the place where she lies must not be so confined by the land that he cannot get away from moorings at all times, regardless of the direction of the wind and tide. These are the chief requirements of a place for moorings when considered simply as such; but there is one point in connection with them that is of more importance than everything else; and it is this—that they should not be more than a quarter of a mile at the utmost from the house of the owner. This does not strike one at first as being of such vital importance as it is; but in practice its value cannot be over-estimated. To live miles, or even one mile, from one's boat, makes it drudgery to get at her. Besides the time which is wasted, there are many entire cruises lost; for a correct judgment as to the state of the weather, either present or future, can seldom be formed except on the coast or on board. The man who lives close to the water knows the exact state of the wind and weather, and can board his boat immediately and avail himself of a favourable opportunity; whilst under other circumstances he would very likely have stayed at home under a false impression, or perhaps have incurred disappointment by coming all the way to his boat only to find that the day was not fit for sailing. The want of a convenient anchorage is, in fact, fatal to the proper appreciation of a small yacht.

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